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Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., F.R.Met.Soc., and E. S. GREW, M.A.

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Enlargement of "Knowledge & Scientific News."

OUR December number will contain a four-page supplement, dealing with "Aëronautics." In it will be found articles, notes, and illustrations dealing with the various branches of aërial navigation; and if this new feature of "KNOWLEDGE & ILLUSTRATED SCIENTIFIC NEWS" meets with sufficient approval and support on the part of our readers, it is proposed to make it a regular feature of the publication. The supplement will be an addition to the usual contents of "KNOWLEDGE."

Multiple Lightning Flashes.

By WILLIAM J. S. LOCKYER, M.A., Ph.D., F.R.A.S.

(*Continued from page* 221.)

Having become acquainted with the facts that lightning flashes may or may not leave a momentary afterglow, and that the form of the trails of the after-glow on the photographic plate depends on the particular movement given to the camera, the reader is in a position to interpret some of the peculiar features of many of the photographs of multiple lightning flashes. We now come to describe and illustrate some among the numerous photographs that have been taken, and which clearly demonstrate that flashes are very commonly of a "multiple" nature, consisting sometimes of three, four, five, or even six or more individual components.

The first to be described is one taken by Dr. B. Walter, at Hamburg, on the night of May 30, 1902. (Fig. 4.) This was secured with his specially mounted camera, to which reference has already been made. The first of the five components of the "quintuple" flash on the left-hand side of the illustration was the initial discharge, and the others followed in rapid succession. The first point to notice is the exact parallelism between all the main discharges, and even the corresponding ramifications or branches. In fact, the last flash is a complete replica of the first, leaving out of consideration the branches. This clearly shows that the main air channel formed by the first discharge was used by all the subsequent four flashes.

As the camera was moving uniformly, it will be observed that there was, comparatively speaking, quite a long interval between the fourth and fifth discharges. By a series of measurements, Dr. Walter determined the intervals of time between the separate discharges, and, counting from left to right, the results, in fractions of a second, were as follows:—0.036; 0,036; 0.028;

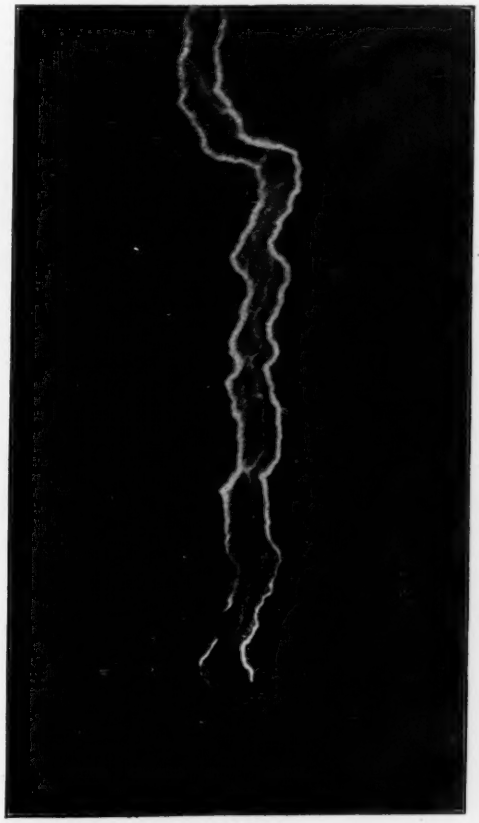

Fig. 7.—A "quadruple" flash photographed at Münster, in Westphalia, on July 25, 1894, 9.10 p.m., by Dr. J. Precht.

0.144. The whole flash was, therefore, computed to have lasted 0.245 seconds, or about one quarter of a second.

This photograph is of further interest, because it shows clearly the general tendency, in nearly all "multiple" lightning pictures, of the disappearance or fading out of the ramifications in the subsequent discharges. The fact that the last two discharges have

no branches at all suggests either that the main channel had been made sufficiently large to carry the whole current without leakage, or that the current itself had become considerably reduced in intensity.

As will be seen from some of the later examples of "multiple" flashes, the latter explanation seems to be the more tenable of the two.

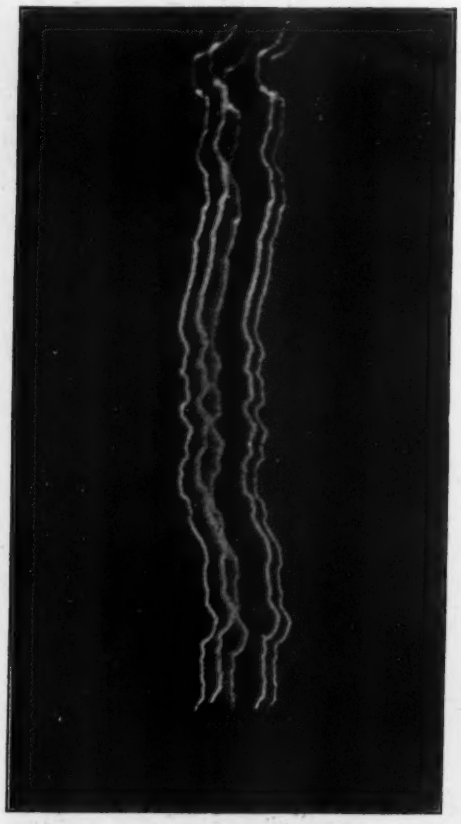

Fig. 8.—A "quintuple" flash photographed at Münster, in Westphalia, on July 25, 1894, by Dr. J. Precht.

With this photograph before one, it may be pointed out that there has been no tendency for any of the flashes, not even the main discharge, to leave any trace of a trail as the camera moved, in spite of the fact that the discharge was a brilliant one. In this case the air channel must have cooled very quickly between the discharges.

The next example is from a photograph which was taken by Mr. J. P. Wilkie, in July, 1902. (Fig. 5). In this case we have, at first sight, a "quadruple" or rather "quintuple" multiple flash, for the fourth discharge has a fainter companion close to it on the right hand side. As a matter of fact the second discharge has also a weak companion on its right hand, so that six individual components form this multiple flash. The camera was moved in the hand nearly horizontally from left to right. In this photograph we have an instance of the gradation of intensity in the series of main flashes, showing the gradual weakening of the discharge from the first to the last.

It will again be seen that all the flashes are practically parallel to one another, the knot in the flash being also faithfully reproduced in every instance.

The next photograph is of rather special interest, since it was one of, if not, the first that settled an important point relative to multiple flashes. Up to the year 1889, flashes had been photographed which appeared on development to be multiple, but the similarity and parallelism of the images were then generally explained by such causes as the effects of halation from the back of the negative, blurring on account of the photograph having been taken through the glass of a window, or some such similar cause. Dr. Hoffert hoped to settle the question by photographing flashes with the camera in motion, in order, if possible, to separate the individual flashes on the plate. The success that he achieved is shown in Fig. 6, which is the reproduction from the photograph which he took on June 6, 1889. The camera was held in the hand and moved in a horizontal plane about the lens as a centre, at the rate of about once to and fro in three quarters of a second. In his description of this photograph (*Phil. Mag.*, August, 1889, p. 106), he tells us that during the interval that the plate was exposed (about half-a-minute), the illumination of the sky and other flashes outside the field of the lens produced the glare in the centre and upper part of the picture.

In spite of this, however, the triple nature of the flash is clearly seen. A careful study of this photograph displays many interesting features, but it is sufficient here to note that the ramifications are not reproduced in the last two discharges, and the intensities of the consecutive flashes diminish as in the other two cases already described.

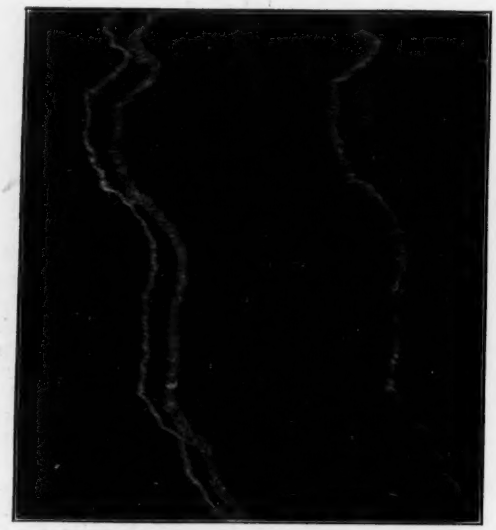

Fig. 9.—A "triple" flash showing that the direction of motion of the camera had been reversed between the second and third flashes counting from the left. Photographed by Mr. J. P. Wilkie.

Further, we have here an example where the afterglow of the primary flash was so strong at several portions of its track that its trail can be clearly traced from flash to flash.

In the photography of multiple flashes, the faster the camera is moved the more separated are the successive discharges on the photographic plate. In all the above instances, the camera was moved briskly. It is not, however, at all necessary to move the camera quickly to prove the multiple nature of a flash.

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These two excellent multiple flashes (Figs. 7 and 8) were photographed by Professor Precht during a storm at Münster, in Westphalia, on July 25, 1894, between 8 and 10 o'clock in the evening. In this case

Fig. 10.—A "multiple" flash photographed at Budapest in August, 1902, by Dr. L. von Szalay.

the camera was held in the hand and moved right and left, each oscillation lasting about 1.2 seconds. Professor Precht observed as well as photographed the flashes, and he says that the discharges appeared to follow one another quickly, with different intensities. In "Himmel und Erde," for the year 1895, No. VII., 4, he describes both these flashes in detail, but for the purpose of this article it is only necessary to draw the reader's attention to their multiple nature. It is interesting to note that the middle flash shown in Fig. 8 was sufficiently bright to record a distinct trail, from which the direction of motion of the camera can be deduced.

It sometimes happens that the time intervals between the individual discharges of a multiple flash are so great that some of the flashes can be photographed when the camera is being moved in one direction, and others when the camera is moved in the reverse direction. Fig. 9 illustrates such a case, and many others might be shown as well. The parallelism of the flashes indicates that a multiple discharge was in question and, counting from left to right, the first two flashes have trails on their right-hand side, and the third a trail on its left.

Fortunately the individual discharges are so well separated that it is quite easy to account for the trails by the explanation given in a preceding paragraph.

In one case with which I am acquainted the camera was moved such a little that while the individual components of the discharge left a trail the resulting flash gave a very peculiar appearance suggesting an extraordinary form of lightning.

To my mind it was at once evident that the movement of the camera was the sole cause, and not any peculiarity of the flash. The case to which I refer is one which was fully described in the *Meteorologische Zeitschrift* for August, 1903 (p. 341), by Dr. Ladislaus von Szalay, of Budapest, who secured the photograph. The photograph is reproduced in Fig. 10.

In order to find out whether, during the exposure, the camera was rigidly fixed or not, I communicated with Dr. von Szalay, and he replied "that the camera was *held still* in the hand." After what has been stated in a preceding paragraph about the difficulty of holding a camera perfectly still, more especially on a dark night with brilliant lightning flashes and heavy thunder close at hand, I think it may be safely assumed that in this case the camera received an unintentional movement during the exposure, the trails of the flashes indicating the direction of the motion given.

Another instance of a peculiar photograph of a lightning flash is that which was described and illustrated by Fr. Klingelfuss in the Smithsonian Report for 1904, p. 259. Herr Klingelfuss describes the flash as an instance of "spiral lightning," and states that a similar screw-shaped formation may be observed under certain conditions in the discharge of an induction coil. The flash is illustrated in Fig. 11, and was taken on the night of July 15, 1902, between 11 and 12 o'clock, near Basel.

Now, the reader will probably at once notice that this photograph bears a close resemblance to that already shown in Fig. 3, which was taken with a camera moving in a curve. If Fig. 3 is not sufficiently like

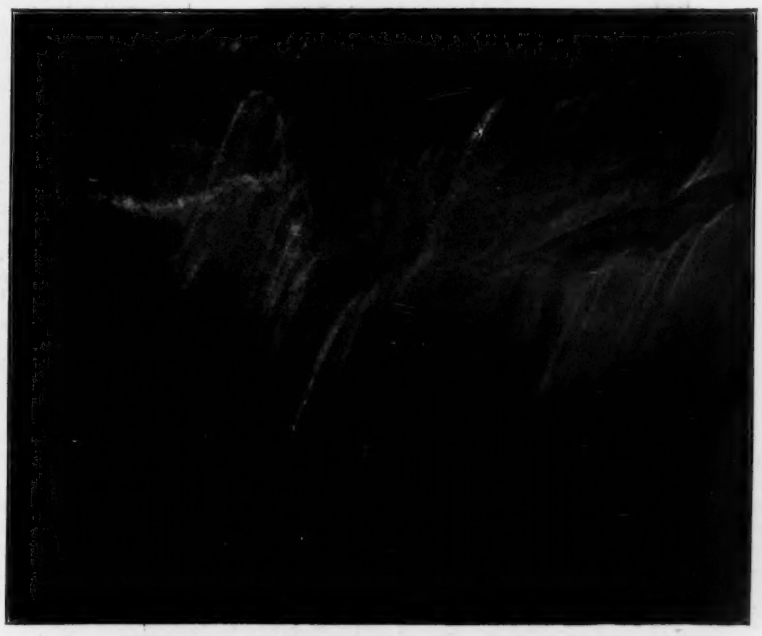


Fig. 11.—"Spiral" lightning as photographed by Herr Klingelfuss near Basel on July 15, 1902.

it, then another photograph by Professor Weber, Fig. 12, bears a still closer resemblance. This also was taken with a camera moved by hand with an elliptic motion.

Fig. 12.—A "multiple" flash taken with a camera moved elliptically. Photographed on July 2, 1889, by Prof. L. Weber.

In Herr Klingelfuss' account, to which reference has been made, he states: ". . . I obtained, in a fixed camera, a photograph of a very extraordinary lightning phenomenon." Wishing to know how the camera was

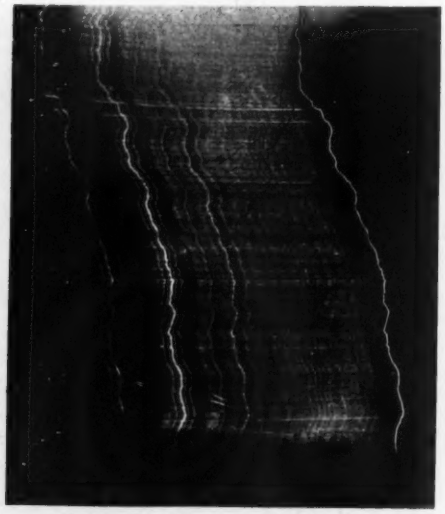


Fig. 13.—A multiple lightning flash taken with a moving camera. Photographed by Alex. Larsen, at Chicago, on September 1, 1905, at 9 p.m.

fixed, I communicated with him, and he courteously replied, "The photographic camera was tightly *pressed* against an upright post of a door-frame during the exposure of the objective, so that a movement of the camera during the exposure was quite out of the question."

Without entering further into the discussion, I think we may safely say that an unintentional movement of the camera, under the circumstances was *possible*, and that, therefore, the photograph is more easily explained on the assumption of "movement of camera" than the suggestion of a new and peculiar form of lightning.

The last multiple photograph to which reference will here be made is one which was secured by Mr. Alex Larsen on September 1, 1905, at 9 p.m., at Chicago, and the apparatus used by him was that which has already been briefly described above. Fig. 13 shows, perhaps, the most interesting of the series which he has taken; the first flash photographed was that on the right-hand side.

The reader will observe that we are here not in the presence of three, four, or ten individual flashes, but that the whole "multiple" flash was composed of forty or more different discharges! This multiple flash, together with another which he secured on July 17, 1902, seems quite unique with respect to the great number of components photographed, and serves to show the importance of this method of studying discharges of lightning.

We thus see that the examination of a great number of photographs of lightning flashes indicates that the occurrence of a *single* flash is far more often the exception than the rule, and that it only requires a movement of the camera, a method only more recently brought into common use, to indicate their multiple nature.

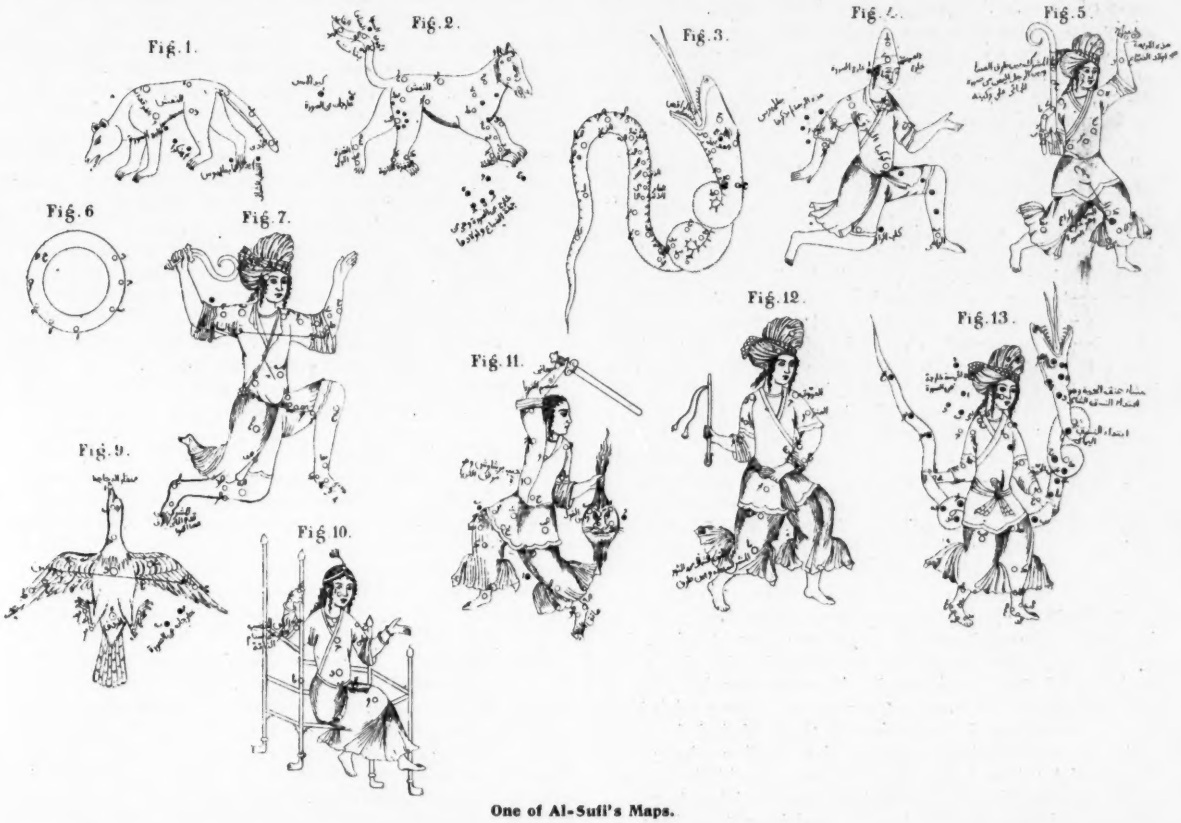
An Astronomer of the Tenth Century.

By J. ELLARD GORE, F.R.A.S.

IN the year 1874 the late M. Schjellerup, the eminent Danish astronomer, published a French translation of two Arabic manuscripts written by the Persian astronomer, Al-Sufi, in the tenth century, and entitled "A Description of the Fixed Stars." One of these manuscripts is preserved in the Royal Library at Copenhagen and the other in the Imperial Library at St. Petersburg. There are two copies of Al-Sufi's work in the Imperial Library at Paris, but these are inaccurate. There is also one in the library of the British Museum and another in the India Office Library, but these are imperfect, considerable portions of the original work being missing. The copy of Al-Sufi's work in the Royal Library of Copenhagen is an Arabic manuscript purchased by Niebuhr in 1763. It is in large and legible writing. The punctuation is almost complete, and sometimes even the vowels are given. It is a copy made in the year A.D. 1601 from a manuscript copied in A.D. 1013 directly from Al-Sufi's copy. The pictures which accompany the text in this manuscript are rather neatly drawn and coloured. The second manuscript, that of the Imperial Library of St. Petersburg, is in a running hand, and very elegant, but for the most part unprovided with diacritical points. The pictures of the constellations are of extreme delicacy, but without any artistic merit.

Very little is known of Al-Sufi's life, and the few details we have are chiefly derived from the works of the historians Abu'l-faradj and Casiri, and the oriental writers Hyde, Caussin, Sédillot, &c. Al-Sufi's com-

plete name was Abd-al-rahman Bin Umar Bin Muhammad Bin Sahl Abu'l-husaïn al-Sûfi al-Razi. The name Sufi indicates that he belonged to the sect of Sufis (Dervishes), and the name Razi that he lived in the town of Raï, in Persia, to the east of Teheran. He was born on December 7, A.D. 903, and died on May 25, 986, so that, like many other astronomers, he lived to a good old age. According to ancient authorities, Al-Sufi—as he is usually called—was a very learned man, who lived at the Courts of Schiraz and Bagdad under Adhad al-Davlat, of the dynasty of Buïdes, who was then the ruler of Persia. He was held in high esteem by this Prince, who said of him, "Abd-al-rahman al-Sufi taught me to know the names and positions of the fixed stars, Scharif Ibn al-Aalam the use of astronomical tables, and Abu Ali al-Farisi instructed me in the principles of grammar." Prince Adhad al-Davlat died on March 26, 983. According to Caussin, Al-Sufi also wrote a work on astrology and a book entitled "Ardjouze," which seems to have been written in verse, but its subject is unknown. He also appears to have determined the exact length of the year and to have undertaken geodetic measurements.



One of Al-Sufi's Maps.

Although Al-Sufi's work is mentioned by the writers above referred to, no complete translation of his manuscript was made until the task was undertaken by Schjellerup, and even now his name is not even mentioned by the writers of some works on astronomy. But he was undoubtedly the best of all the ancient observers, and his work is deserving of the most careful consideration.

Al-Sufi's description of the stars was, it is true, based on Ptolemy's catalogue, but it is not a mere translation of the work of his predecessor. It is, on the contrary, a careful and independent survey of the heavens made from his own personal observations, each of Ptolemy's stars having been carefully examined and Ptolemy's mistakes corrected. He seems to have accepted the positions of Ptolemy (or Hipparchus), merely correcting them for the effect of precession, but he made a very careful revision of the star magnitudes of Hipparchus and Ptolemy from his own observations, and this renders his work the most valuable, from this point of view, of all the ancient catalogues. In examining his descriptions "we soon see the vast extent of his labours, his perseverance, and the minute accuracy and almost modern criticism with which he executed his work." In fact, he has given us a careful description of the starry sky as it appeared in his time, and one which deserves the highest confidence. It far surpasses the work of Ptolemy, which had been for eight centuries previously without a rival, and it has been only equalled in modern times by the surveys of Argelander, Behrmann, Gould, Heis, and Houzeau. Plato remarked with reference to the catalogue of Hipparchus, *Coelum posteris in hereditatem relictum*, and the same may be said of Al-Sufi's work. In addition to his own estimates of star magnitudes, Al-Sufi adds the magnitude given by Ptolemy, whenever Ptolemy's estimate differs from his own, and this makes his work still more valuable, as Ptolemy's magnitudes given in all the editions of the Almagest now extant are quite untrustworthy.

Al-Sufi seems to have been a most careful and ac-

curate observer, and although, as a rule, his estimates of star magnitudes are in fairly good agreement with modern estimates and photometric measures, there are many remarkable and interesting differences to be found in his work. His observations have an important bearing on the supposed "secular variation" of the stars; that is, the slow variation in light which may have occurred in the course of ages in certain stars, apart from the periodical variation which is known to occur in the so-called "variable stars." More than 900 years have now elapsed since the date of Al-Sufi's observations (about A.D. 964), and over 2,000 years in the case of Hipparchus, and although these periods are, of course, very short in the life history of any star, still some change may possibly have occurred in the brightness of some of them. A diminution of brightness seems certainly to have occurred in the case of θ Eridani, β Leonis, o Persei, χ Centauri, &c. On the other hand, some stars, like γ Geminorum, β Canis Majoris, and others, have apparently increased in brightness, and the bearing of these changes on the question of stellar evolution will be obvious.

In most cases Al-Sufi merely mentions the magnitude which he estimated a star to be; such as "third magnitude," "fourth magnitude," "small third magnitude," "large fourth magnitude," &c. In some cases, however, he directly states that a certain star is brighter than another. Such cases—which, however, are unfortunately not numerous—are very valuable for comparison with modern estimates and measures, whenever variation is suspected in the light of a star. They show that he actually compared the stars with each other, as is done by modern observers. Al-Sufi's estimates are given in thirds of a magnitude. Thus, "small third magnitude" means $3\frac{1}{3}$, or 3.33 magnitude; "large fourth" $3\frac{2}{3}$, or 3.66 magnitude. This method corresponds with that of Argelander, Behrmann, Heis, and Houzeau in their catalogues of stars visible to the naked eye.

I have made a careful examination of Al-Sufi's descriptions (as given by Schjellerup) and a comparison of his estimates of magnitude with modern estimates and measures, and in some cases with my own observations made during the past 30 years in India and in Ireland. I have also made an independent identification of all the stars mentioned by Al-Sufi. In the great majority of cases my identifications concur with those of Schjellerup, but in some cases I cannot agree with him. In a few cases I have found that Al-Sufi himself, although accurately describing the position of the star observed by *him*, has apparently misidentified the star observed by Hipparchus and Ptolemy. This becomes apparent if we plot Ptolemy's positions (as given by Al-Sufi) and compare them with Al-Sufi's descriptions of the stars observed by him. This I have done in all cases where there seems to be any doubt, and in this way I have arrived at some interesting results, which have escaped Schjellerup's notice.* This examination shows clearly that Al-Sufi did not himself measure the *positions* of the stars he observed, but merely adopted those given by Ptolemy, corrected for the effect of precession. The value of his work, however, consists in his estimates of star magnitudes, which seem to have been most carefully made, and from this point of view his work is invaluable. Pierce says: "The work which the learning of M. Schjellerup has brought to light is so important that the smallest errors of detail become interesting."

To show the usually great accuracy of Al-Sufi's estimates of star magnitude I give the following examples (among many others) of his estimates compared with modern estimates and photometric measures:—

Star.	Magnitude.			Photometric Measures. Harvard.
	Al-Sufi.	Argelander.	Heis.	
α Tauri	1	1	1	1·06
β Aurigæ ..	2	2	2	2·07
δ Ophiuchi .	3	3	3	3·03
ν Persei	4	4	4	3·93
κ Cassiopeiæ	4·5	4·5	4·5	4·24
h Draconis .	5	5	5	4·98
η Arietis....	5·6	5·6	5·6	5·37

In his preface to the translation of Al-Sufi's work, Schjellerup mentions some remarkable discordances between the magnitudes assigned to certain stars by Ptolemy and Argelander. This comparison is worthy of confidence, as we know that both Al-Sufi and Argelander adopted Ptolemy's (that is, Hipparchus') scale of magnitudes. For example, all these observers agree that β Ursæ Minoris (Ptolemy's No. 6 of that constellation) is of the 2nd magnitude, while in the case of γ Ursæ Minoris (Ptolemy's No. 7), Ptolemy called it 2nd magnitude and Argelander rated it 3, Argelander thus making γ one magnitude fainter than Ptolemy's estimate. Now Al-Sufi, observing over 900 years ago, rated γ of the 3rd magnitude, thus correcting Ptolemy and agreeing with Argelander. Modern photometric measures confirm the estimates of Al-Sufi and Argelander, but it is, of course, possible that one or both of these stars may be variable, and β has actually been suspected of variable light. Almost all the constellations afford examples of this kind. In the majority of cases, however, Al-Sufi agrees well with Argelander and Heis, but there are in many cases differences which suggest a change in relative brightness.* Schjellerup refers to the stars e (Flamstead 18), f (Fl. 15), and Ψ in the constellation Ursa Major, Al-Sufi's estimates of which are intermediate between those of Ptolemy and Argelander; but I think better examples than these can be easily found.

The difference between Ptolemy and Argelander rarely exceeds one magnitude, but there are some cases in which the discrepancy is greater. Schjellerup mentions the case of Ptolemy's No. 25 in Orion (π^6 = Flamstead 10) and ρ Eridani (Ptolemy's No. 15). These stars were rated by Ptolemy (or Hipparchus) of the 3rd and 4th magnitude respectively, but Argelander estimated them 5-4 and 6. Al-Sufi made them 4 and 5, which is again intermediate between the estimates of Ptolemy and Argelander. With reference to ρ Eridani, however, there may possibly, I think, be some confusion between the magnitudes of ρ^1 and ρ^2 seen as a single star by the naked eye and their actual magnitudes as seen *separately* with a telescope or opera-glass. This may, perhaps, account for the low estimate of Argelander. Heis gives ρ^1, 5-6, and ρ^2, 6 magnitude. The photometric magnitudes are 5.45 and 5·43.

With reference to the supposed red colour of Sirius in ancient times, Schjellerup thinks it very doubtful that it was really noted as red by Hipparchus and Ptolemy. Al-Sufi says nothing about its colour, although he mentions several other stars as red. In an exhaustive enquiry made by Dr. See on this sup-

* See *The Observatory*, March, 1904.

* See *The Observatory*, Oct., Nov., Dec., 1900, and Jan., 1901.

posed change of colour in Sirius* he comes to the conclusion that Sirius was really red in ancient times. Seneca states distinctly that it was redder than Mars, and other ancient writers refer to its red colour. It has been generally supposed that the Arabian astronomer Alfraganus, in his translation of Ptolemy's Almagest, refers to only five red stars observed by Ptolemy, namely, Arcturus, Aldebaran, Betelgeuse, Antares, and Pollux; but Dr. See shows that this is due to a mistranslation of Alfraganus by Plato Tibertinus in 1537, and that Ptolemy did not speak of five "red stars," but five "nebulous stars," as stated by Christmann and Golius. Ptolemy described Sirius as 'υπόκιρρος, "fiery red," the same word used with reference to the other stars mentioned above. The change of colour, if any, probably took place before Al-Sufi's time. If it were red in his day he would most probably have mentioned the fact.

Al-Sufi distinctly describes the variable star Algol as red in his time. He speaks of it as "The bright star of a red colour and small second magnitude. It is found in the head of *al-gûl*," and again "The bright red star which is in the head of *al-gûl*." It is now white or only slightly yellow. He also speaks of α Hydræ as red—as it is to-day. In the face of these facts Schjellerup thinks that the change of colour in Algol cannot be doubted, and I fully concur in this opinion. It seems possible that the so-called "dark" companion of Algol, which produces the variation in its light, may have been brighter in Al-Sufi's time and of a reddish colour, which may, perhaps, have tinged the light of the bright star. As I have shown elsewhere, this companion may be even now of the 4th or 5th magnitude without the telescope or spectroscope showing any sign of its existence.

Among other remarkable things in Al-Sufi's most interesting work may be mentioned the great nebula in Andromeda, which was first noticed in Europe as visible to the naked eye by Simon Marius in 1612. Al-Sufi, however, speaks of it as a familiar object in his day.

With reference to the "precession of the equinoxes," Al-Sufi says that the stars of the Zodiac have a certain movement following the order of the "signs," which, according to Ptolemy and his predecessors, is a degree in one hundred years, but according to those who observed subsequently to Ptolemy, it is one degree in 66 years. According to modern measures the precession is about 50″.24 per annum, or one degree in about 71½ years.

Al-Sufi says that the Arabian astronomers did not make use of the figures of the Zodiac in their proper signification, because they divided the circumference of the sky by the number of days which the moon took to describe it—about 28 days—and they looked for conspicuous stars at intervals which, to the eye, the moon seemed to describe in a day and a night. They began with two stars in the constellation Aries (α and β Arietis), which they called *al-scharataïn*, the two marks. These were the first striking points following the point of the spring Equinox. Following these "two marks" they sought another point at a distance from them equal to the space described by the moon in 24 hours. In this way they found ε, δ, and ρ Arietis, which they called *al-butaïn*, after that *al-tsuraija*, the Pleiades; then *al-dabarân* (Aldebaran); and thus all the other points which they called the "mansions of the moon." They paid no attention to the signs of the Zodiac, nor to the extent of the figures which composed them. This is why they counted among the "mansions" *al-haka* (λ Orionis), which forms no part of the signs of the Zodiac since it belongs to the southern constellation of Orion. And similarly for other stars near the Zodiac, of which Al-Sufi gives some details. He says that Regulus (α Leonis) was called by the Arabians *al-maliki*, the Royal star, and that *al-auva* consists of five stars situated in the two wings of the Virgin. These stars seem to be β, η, γ, δ, and ε Virginis, which form with Spica (α Virginis) a γ-shaped figure. Spica was called *Simak al-azal*, the "unarmed Simak"; the "armed Simak" being Arcturus, *Simak al-râmih*. These Arabic names seem very fanciful. He says that the Arabians called any conspicuous stars which precedes a bright one, that is, goes before it in the diurnal motion, *al-mirzam*. Thus the star β Canis Majoris, which precedes Sirius, and β Canis Minoris, which precedes Procyon, were called the two *mirzam*; so also the star on the left shoulder of Orion, namely, γ Orionis, or Bellatrix, was called *al-mirzam*.

Al-Sufi relates that in the year 337 of the Hegira (about A.D. 948) he went to Ispahan with Prince Abultadhl, who introduced him to an inhabitant of that city, named Ibn Varvadjah, well known in that country, and famous for his astronomical knowledge. Al-Sufi asked him the names of the stars on an astrolabe which he had, and he named Aldebaran, the two bright stars in the Twins (Castor and Pollux), Regulus, Sirius, and Procyon, the two Simaks, &c. Al-Sufi asked him in what part of the sky *al-fard* (γ Hydræ) was, but he did not know! Twelve years afterwards, in the year 349, this same man was at the court of the Prince Adhad al-Davlat—the ruler of Persia—and in the presence of the Prince, Al-Sufi asked him the name of a star—it was the bright star *al-nasr al-vaki*, now known as Vega (α Lyræ)—which was sufficiently high above the eastern horizon, and this Ispahan "astronomer" replied: "Oh! that is *al-aijuk*" (Capella)! thus showing that he only knew the *names* of the stars, but did not know them in the sky. Al-Sufi adds that all the women "who spin in their homes" knew this star (Vega) by the name of *al-atsâfi*, the Tripod. This could hardly be said even of "educated" women at the present day.

Al-Sufi says that he undertook his examination of the heavens and his "Description of the Fixed Stars" on account of the interest in the subject expressed by Prince Adhad Al-Davlat, who wished "to know them himself," and "verify their positions with his own eyes." He says that "many people suppose that the total number of fixed stars in the sky is 1,025 (the number given by Ptolemy), but this is an evident error"; and he explains that, although the stars really visible to the naked eye much exceed this number, still the number of faint stars *just* visible is "too great to count, and this is why they have been omitted." Here Al-Sufi is slightly in error, for the number of stars clearly visible to good eyesight without optical assistance can easily be counted, and shown on charts, and this has been actually done in several modern star maps.

The number of stars described by Al-Sufi is 1,022. Of these the 21 northern constellations contain 360 stars; the 12 constellations of the Zodiac 346; and the 15 constellations of the southern hemisphere 316 stars. He describes the positions of all these stars, "beginning with those nearest to the apparent pole," and then "successively all the others following the order of proximity as Ptolemy has done in his book" (the famous Almagest). Al-Sufi's work is, however, much better than that of Ptolemy, and is certainly the most reliable catalogue of stars which has come down to us from ancient times.

* *Astronomy and Astrophysics*, Vol. XI., 1892.

XUM

The "Coney" of the Bible.

By R. LYDEKKER.

FEW persons other than those brought into contact—either voluntarily or involuntarily—with the criminal law of England appear to be acquainted with the proper meaning of the word "coney" or "cony." Although its original etymology appears to be unknown, it is a derivative from the same root-stock as the Greek *kuniklos*, the Latin *cuniculus*, the Welsh *cwningen*, the German *kaninchen*, the Italian *coniglio*, the Spanish *conejo*, and the French *connil* (now generally superseded by *lapin*). All these names primarily denote the rabbit, which is indigenous in the western Mediterranean countries, although some of them may also have been applied to other burrowing animals. In England the word "coney" seems, however, to have always been restricted to the rabbit, and is still used in summonses for trespass and other legal documents to denote that rodent, although it has otherwise been replaced by the modern term.

When *coney* was replaced in the vernacular by *rabbit* (at one time *rabbet*, and still earlier *robbet*), it is not easy to ascertain. Pennant, however, in his "British Zoology" (1766), writes of the rabbet or coney; while Gilbert White (*circa* 1770-1790) uses the modern name and spelling in the one passage where the animal is mentioned. *Rabbit*, or *robbet*, it may be incidentally mentioned, is the equivalent of the Dutch *robbe* and *robbeken*, which have been supposed to be derived from the Latin *rapidus*. Another suggestion is, however, that *robbet* is a corruption of *rough-foot*; and if this be true, rabbit is the exact English of the Greek *dasypous* and the Latinised *dasypus*, the former of which was, in classic times, the name of the hare, although in Pliny it is apparently used to denote the rabbit. In modern zoology the Latinised form has been transferred to the armadillo.

When the translators of the authorised version of the Bible came to the word *shaphan* in the well-known passages in Proverbs xxx. and Psalm civ., which, from the context, evidently indicate a small quadruped dwelling among rocks and hiding in their interstices, they not unnaturally concluded that the coney was the animal referred to, being quite unaware that it is unknown in Syria and the neighbouring countries. That they made a bad shot is certain, but the mistake is quite excusable, and (although the *shaphan* has no more to do with a rabbit than it has with a cat) it is difficult to see how they could have done much better, short of retaining the original Hebrew word, for at that time the creature in question was probably unknown in Europe, and certainly had no distinctive English name.

For that matter, it has practically none at the present day; and it is a matter of considerable difficulty to decide upon a satisfactory artificial title. That it is inadmissible to follow the Bible translators and to call the *shaphan* the *coney* is perfectly clear, although this has been done by a well-known American writer in the October number of the *Century Magazine*.

In scientific zoology the *shaphan* was for many years known as *Hyrax syriacus*, but it has latterly been discovered that it has an earlier generic title, and it is, in consequence, now generally called *Procavia syriaca*. Etymologically both these names are singularly unfortunate and misleading, *hyrax* being the Latinised form of the Greek *hurax*, signifying a shrew-mouse, while *procavia* indicates an animal nearly related to the guinea-pig; and the *shaphan* has no more kinship with either of these animals than it has with the coney. Such matters, although annoying to the etymologist, are, however, not regarded by naturalists as of much moment.

In addition to the Syrian *shaphan*, there are a number of more or less nearly allied representatives of the same group spread over Africa. To the one inhabiting Cape Colony the Dutch have given the name *klip-dass*, equivalent to rock-badger, a term which has been modified by the English colonists into *dassie*. The former name, whether in the original Dutch or translated, is

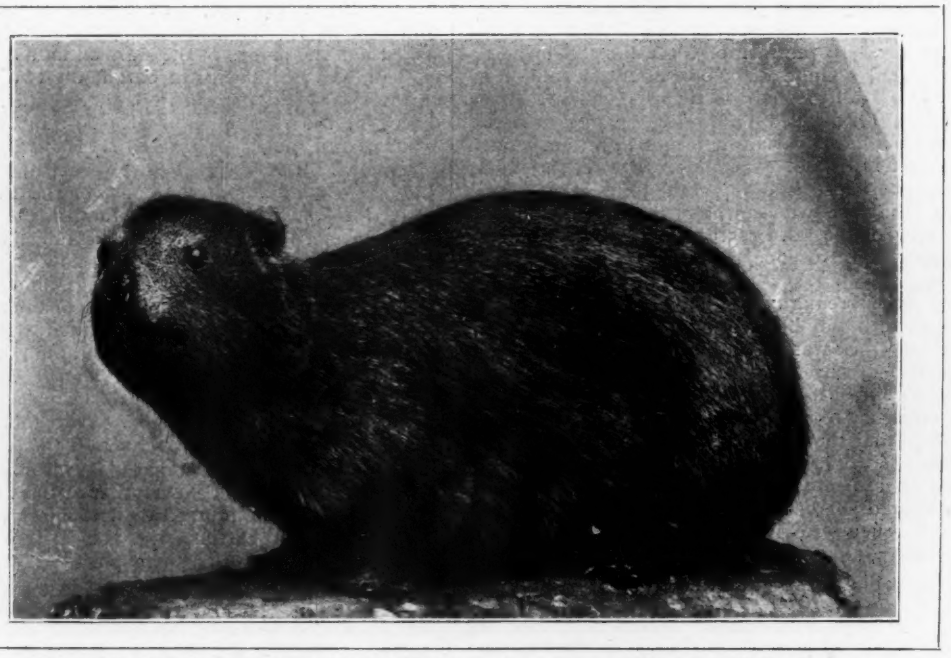


Fig. 1.—The Cape Hyrax, a near relative of the Syrian species. (From a specimen in the British Museum.)

quite as objectionable as rock-coney (which has been suggested as a substitute for coney, pure and simple); firstly for the reason that the creature has nothing in common with a badger, and secondly because some of its African relatives are tree-climbers. "Dassie" has too much the character of slang to be suitable for general adoption.

We are, therefore, driven to adopt as the English designation of these animals either the discarded scientific name *hyrax* (for *procavy* would scarcely do) or the Hebrew *shaphan*. It is a choice of evils, but of the two hyrax appears the less objectionable; although if either of these titles were introduced into our translation of the Old Testament, it is probable that ordinary readers and listeners would not be much the wiser.

To the naturalist the Syrian hyrax and its African relatives are some of the most interesting of all living quadrupeds. Unknown in the extreme north (which is, zoologically, a part of Europe), hyraxes are found, in suitable situations, throughout most of the rest of Africa, but, with the exception of the outlying Syrian species, which extends into Arabia, are unrepresented in any other portion of the globe. Till a few years ago they were supposed to have no near relations, either living or extinct, and thus to form an isolated, and, so to speak, friendless, group by themselves. Discoveries in the upper Tertiary formations of the island of Samos have, however, enabled naturalists to determine that certain problematical jaws and teeth known long previously from the corresponding rocks of Greece indicate comparatively gigantic extinct species of the group. Still more recently the wonderful discoveries of fossil quadrupeds in the lower Tertiary rocks of the Fayum district of the Libyan desert have revealed the former existence of quite a number of extinct relatives of the hyrax, most of which largely exceeded their living representatives in the matter of bodily size.

The present geographical distribution of the hyrax group is of itself sufficient to suggest the idea that these animals originated in Africa; and this supposition has been converted into a certainty by the discoveries to which allusion has just been made. It appears, indeed, that in early Tertiary times Africa was the home of a very remarkable assemblage of animals, comprising the ancestors of the modern elephants, hyraxes, and sea-cows, but with no representatives of the giraffes, antelopes, buffaloes, and hippopotamuses which are now so characteristic of that continent.

In the completely isolated Africa of those days the aforesaid animals continued to develop and flourish by themselves till the time came when a substantial connection was established with the great northern continent. The elephants immediately took advantage of the bridge to make their way northwards, and thus to spread over nearly the whole of the globe, although they now survive only in India and in the old African home. The hyraxes, on the other hand, which appear always to have been, like their modern Syrian representative, "a feeble folk," were evidently not such good travellers, and only succeeded in making their way into the countries fringing Africa, such as Greece, Samos, Syria, and Arabia, where they survive at the present only in the two last of these, in the form of the diminutive Biblical species. At no time did they effect an entrance into Madagascar, which has been isolated from the ethiopian mainland for untold ages.

Before proceeding to notice some of the features which render the hyraxes unlike all other living animals,

Fig. 2.—The Skull of a Hyrax.

it may be mentioned that these creatures are included in the great order of ungulate, or hoofed, animals, of which they form a special group, or sub-order. One reason for thus associating them is the fact that the toes, of which there are four functional ones in front and three behind, are protected by broad nail-like hoofs, closely resembling those of a rhinoceros. Indeed, the whole hind-foot is remarkably similar to that of the latter animal. A second reason is that the molars, or cheek-teeth, also approximate to the rhinoceros-type, although they are more like those of certain extinct European animals allied to both rhinoceroses and tapirs.

The skull of a hyrax (Fig. 2) is, however, unlike that of any other living ungulate in that the front of the upper jaw is armed with a single pair of long dagger-like teeth, widely separated from another in the middle line, and likewise sundered on each side by a long space from the teeth of the cheek-series. These dagger-like tusks (which do not correspond to the canine teeth of a dog) are, it is believed, largely used for fighting, the

disposition of the hyrax being apparently far from amiable. Occupying a corresponding position in the lower jaw are two pairs of somewhat peg-like teeth, of which the inner ones are separated by a small interval in the middle line, and are characterised by a somewhat comb-like or grooved structure.

This peculiar type of dentition, together with a number of other anatomical features into the consideration of which it would be out of place to enter on this occasion, amply justifies the relegation of the hyrax to an altogether isolated position in the order of hoofed quadrupeds.

Its dentition also widely separates the hyrax from the rabbit, which, it is almost needless to mention, has a single functional pair of closely approximated chisel-like teeth in the front of each jaw.

Nevertheless, the hyrax presents a superficial resemblance, both in size and general appearance, to a very short-eared rabbit (and there is such a creature, although it was quite unknown to the translators of the Bible), the tail being extremely short. The fur of the hyrax is, however, of a rather darker colour, and the flat hoofs or nails are, of course, quite unlike the curved claws of the rabbit.

Careful examination will reveal near the middle of the back of the hyrax a patch of hair somewhat lighter in colour than that by which it is surrounded. This patch covers a gland, which not improbably, unless removed immediately after death, would communicate an unpleasant taste to the flesh. Whether the presence of this gland had anything to do with the prohibition of "coney" meat as an article of diet to Hebrews, it is impossible now to say.

The ostensible reason of the prohibition was that the "coney," like the hare, chewed the cud without "dividing the hoof." As a matter of fact, neither the hyrax nor the hare really chews the cud—a function which is strictly confined to ruminants. Nevertheless, the peculiar movements of the lower jaw and lips of both these animals when feeding might readily convey the idea to non-scientific observers that they really ruminate.

The Syrian hyrax, as is so well indicated in the Bible, like many of its nearest relatives, dwells in companies amid rocks, and is a strict vegetarian. There are, however, a number of African species which spend their time in the trunks and larger branches of trees, the holes in which afford them comfortable sleeping places. These tree-hyraxes, as they are called, have the habit of hunching up their backs into the form of a high arch, which gives them a most peculiar appearance when at rest. As a rhinoceros-like foot is not very well adapted for holding on to smooth surfaces of rocks or the bark of trees, these animals have the power of elevating the centre of the sole so as to form a sucker, and are thereby enabled to clamber or climb about in either situation with facility.

A Practical Microscopist.

THE *Revue Scientifique* calls attention to the recent death of Mr. G. E. Davies, of Manchester, founder and editor of the *Chemical Trade Journal*. Mr. Davies was also the first secretary and afterwards a vice-president of the Society of Chemical Industry, and author of "Chemical Engineering." His interests were not confined to chemistry, for at one time he held the office of president of the Manchester Microscopical Society, and in 1882 he brought out an excellent book, entitled "Practical Microscopy," somewhat on the lines of "Carpenter," but smaller.

Nature Notes from Liphook Villagers.

By M. FOWLER.

LIPHOOK is situated on the borders of Woolmer Forest, and within a walk of Selborne. Much natural history has been written of the neighbourhood, but the observations and deductions of trained naturalists are very different from those of villagers, and the following records are gleanings from this latter class. According to them, I gather what scientific men have not apparently realised, how that the toad is an efficient natural filter, and in this one capacity invaluable to mankind. The reason why toads are so poisonous is very simple. They absorb impurities from water. If one be placed in impure water, it will, in a short time, render it sweet and even fit for drinking purposes, though the poor creature becomes ever more and more dangerous in consequence. They have many unpleasant habits to counterbalance this satisfactory property, one of which is to eject white frothy "toad-spit" over plants and flowers. Judging from the position of this dangerous deposit, it is sometimes wonderful how far up a lavender bush such clumsy-looking reptiles are able to climb. It is advisable never to handle a toad, as should one catch hold of your finger it will never leave go of it again.

All English reptiles are harmful to man—generally very harmful. The common adder or viper, though blind and deaf, is an interesting, if perilous, creature. What is commonly supposed to be merely a characteristic marking down the back is, in reality, "Chinese writing," which, being interpreted, runs as follows:—

"If I could hear and also see,
No bird or beast should pass by me."

—a bloodthirsty statement, but a true key to the nature of the beast. No adder should be allowed to live, all must be killed as soon as seen, or rather, all must be more or less killed, for, in common with earthworms, snakes possess the peculiarity of being unable to die before sunset. The mangled body may appear dead, but on close inspection some movement will be discernible. True, there are authorities who doubt this fact, and assert that adders *can* be killed outright, their tails only retaining vitality as long as daylight lasts. Vipers' fat is a grand cure for vipers' bites, also for the bites of dogs, and on this account it is well to collect and bottle the valuable commodity, taking the one necessary precaution of seeing that it is scraped from either side of the backbone "while the reptile is warm," that is, as soon as you have tried to kill it. A gamekeeper on one of the Liphook estates always collected and preserved adders' fat, and might be applied to by all in need of the cure. A bite from this snake is a dangerous thing; still, after much suffering, its victims may recover; not so, however, if the injury be inflicted by the smaller but more deadly heath adder. Fortunately this latter is rare, and may be easily distinguished by the ruddy colour of its scales, through which is dimly seen in darker shade the zigzag motto down the back. As they are quick in their movements, and live only on commons where the ling grows thickly, they are seldom seen except by cow-boys, wood-gatherers, or heath-cutters.

It is a pleasure to turn from such unpleasant creatures and contemplate instead the cheerful harmlessness of the chaffinch. To the commonplace ornithologist the song is somewhat harsh and monotonous

withal, but this is a mistake. Few birds say as much in so few words. Its commonest assertion is heard all summer long: "No little bird builds its nest like *I* do." This may sound conceited, but the chaffinch is very self-confident; it is also of a hopeful disposition, and may be heard calling, "If he lives till next year he shall have a bunch of *wheat* ears," or, as a variety, "Only a few more weeks and we'll have some new *wheat* ears."

How different a bird is the puckeridge—the soul of an unbaptised infant, cursed with evil powers and malignant attributes, and doomed to fly around the village where its earthly tenement lies buried. It is "an ill-meaning bird, and has a lot of poison about it." Also it is a sort of hawk, and makes a noise "like a door-latch rattling up and down." So nasty are these spirits in disposition, they will fly in giddy circles round animals and passers-by, trying to inflict a blow with their wings. Should they succeed in touching the head of a child or calf, development will be arrested, and the victim die or become a dwarf. Notwithstanding, they are valiant mothers, and if any person venture near their young, will fly at their eyes, and, on drawing blood, certainly kill them. The eggs are poisonous, and must, therefore, be left severely alone, never on any account handled, much less placed in collections. Both they and the young are tenderly cared for by the parents, and carried to a place of safety if in any way disturbed. This is a good trait in an otherwise objectionable character. The puckeridge can also prove a good weather prophet, for when it flies from tree to tree in the evening, fine, hot days may be expected.

We are ascending in the animal scale as we progress; now is the time to consider the mole. I have been told in Lincolnshire that a certain large brown chrysalis, sometimes unearthed in the neighbourhood of potatoes, eventually turns into a mole. If one thinks of it, why not? Surely it sounds a more likely thing than that it should ultimately become a moth with wings! Lip-hook moles have no such origin. True they are blind, and live below ground, but there the similarity ends. From the first they are moles, and moles only. Many people say they never come to the surface, but with regard to this there is some difference of opinion, as their nests are composed of leaves and dry grass, which must have been collected from the fields and hedges. The case is full of difficulties, and cannot be decided off-hand. One thing is well known, moles only move once in four hours, at twelve, four, and eight o'clock, and when they are moving at four is the best time to catch them. Troublesome maybe, but yet harmless animals, very different to the blind and legless bat, so venomous and destructive to everything it touches, and whose one object in life is to entangle itself in the hair of unoffending females.

These interesting notes have been collected from the villagers, and are firmly believed by all who supplied them.

Answer to Correspondent.

Heliocentric Longitude of Planets.—The mean equinox is the computed place of the ascending node as the average of its varying real positions. Besides precession the celestial pole moves in a small ellipse, and the resultant motion, called nutation, causes a periodic displacement of the node every 19 years. Heliocentric longitudes are measured from this hypothetical mean equinox of the date under consideration.

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Colour Photography.

The Lumière "Autochrome" plates that I referred to two months ago are now obtainable in this country and in English sizes. At the same time another one-plate process for colour photography that is, in some ways, even more ingenious in the method of making the plate, and that gives results that are of more extended application than the "autochrome" plates has just been made known, and several examples of it have been on view. The Warner-Powrie process has been worked out chiefly by Mr. Powrie in Chicago and lately in New York. The particoloured screen underlies the sensitive emulsion, as in the "autochrome" plates, but the colours (red, green, and blue) are in regular lines. These lines of colour are so fine, six hundred or more to the inch, and quite without overlaps or gaps, that the method of their production, though simple, marks a new era in the production of lined screens. Pen ruling will not give satisfactory results, as many inventors have found to their cost. Mr. Powrie's method is to coat the plate with a bichromated gelatinous substance, expose it under a black-lined screen that has lines twice the width of the spaces, and develop it in warm water. The gelatinous coating under the black lines, remaining soluble, is washed away, and the plate is covered with narrow lines of insoluble colloid, each separated from its neighbour by a space double its width. By immersing the plate in a solution of a green dye these lines are coloured, then the colloid is made still more insoluble by suitable reagents to fix the dye. The plate is coated again, exposed so that the new lines shall come in the spaces left before, developed, and treated as before except that the dye is red. After a third coating the exposure takes place merely through the back of the plate itself, the red and green lines already produced effectually shielding the coating from light action, so that the new lines *exactly* fill all the spaces not occupied by the red and green lines. The last dye bath is blue. This coloured plate is coated with the photographic emulsion, and can be used after the manner of an "autochrome" plate. Although the colours are in regular lines instead of irregularly disposed dots, the lines can be made so fine as to be invisible to the naked eye. The stained colloid has the advantage of being more transparent than the stained starch grains, but, perhaps, the chief advantage is the possibility of using such a plate for printing from. White light would obviously be reduced to about one-third its brightness in passing through such a plate, and this represents the brightest white possible. In a transparency this loss of light is compensated for by putting a brighter light behind it (or holding it nearer the light). But if a print were made, for example, on the bleaching-out "Uto" paper that I described last July, the red, green, and blue lines produced under the "white" parts of the transparency would appear as so dark a grey that the result would be useless. A pure red patch in the transparency is red over only one-third its area, the other two-thirds being occupied by the green and blue which are covered with an opaque deposit of silver. On the "Uto" paper this pure red would be one-third red and two-thirds black, a degradation of colour that would render the result useless. By separating the colour transparency from the "Uto" paper by a sheet of celluloid or glass, and using three sources of light (or one light and two mirrors, which

can be attached to the printing frame in a simple way), the light through every line is made to cover the width of three lines on the paper, and the result of this overlap is that there is complete bleaching under the transparency "whites." A pure red patch, by allowing the light that passes through each red line to spread to three times its width on the paper, bleaches to redness the whole area that represents this colour. There are other useful possibilities, when the colours are in regularly disposed lines, that it is difficult, if possible, to realise with an irregular grain. It is not known when the Warner-Powrie plates will be commercially obtainable.

The Effect of Gases on the Production of the Developable Image. About three years ago W. Braun found that a given exposure produced a greater effect on a gelatino-bromide plate if the plate were surrounded by oxygen instead of air, and less if it were in an atmosphere of nitrogen, thus leading to the notion that atmospheric oxygen plays an active part in the production of the developable image. This was opposed to the results of previous investigators. E. Schloemann, in re-examining the question, tested a great many commercial plates, exposing them both wet and dry in a specially made apparatus that could be filled with any required gas, but failed to find that the presence or absence of oxygen affected the sensitiveness of the plates. This is further and welcome evidence in favour of the comparative simplicity of the change that gives the developable condition.

The Sensitiveness of Wetted Plates. There have been a good many observations made, from time to time, as to the change of sensitiveness caused by wetting gelatino-bromide plates. It seems that if water is used, whatever change occurs, the plate regains its original sensitiveness when dried again, and that a more complete drying than is usual, as by their exposure to an atmosphere dried as completely as is possible by desiccating reagents, the sensitiveness is not increased. Developers are similar to plain water in their action, but some colour sensitisers are destroyed by some developers, as cyanine by ferrous oxalate; then the colour sensitiveness cannot be restored by washing and drying. In such cases when exposure precedes the application of the developer, the colour sensitiveness of the plate is not lost so far as the resulting negative is concerned. In general, the effect of exposing a plate while it is wet is to lower its sensitiveness to a degree that depends upon the plate. A few are apparently not affected, some may be reduced to one-tenth their original sensitiveness, but in most cases the reduction seems to be to about a half. Plates sensitised to green and red, especially the latter, as a rule suffer a much larger reduction of sensitiveness to these colours than to blue. Generally, therefore, whatever care may be necessary with regard to the dark-room light during development, greater care is necessary when plates are being manipulated dry, when, for example, they are being put into dark-slides and cameras. The correctness of this commonly received maxim is confirmed.

New Apparatus. Messrs. Taylor, Taylor, and Hobson have recently introduced a reflex camera that is specially notable for its light weight and compactness, combined with efficiency and reliability. The body is made of aluminium and covered with mahogany, so that the advantages of both materials are secured. It has many novel details in its construction. Its general appearance, when the focussing hood is expanded and the front opened for inspection, is shown in the illustration, and the camera itself may be seen at the firm's London office, 18, Berners Street. They have also

ready for issue a "Twin Cooke Lens," which has a focal length of eight inches and an aperture $f/6.5$, and consists of two complete Cooke lenses with focal lengths of fourteen and twenty inches respectively and apertures of $f/11$. The one instrument, therefore, includes three fully corrected anastigmats. A third novelty is a series of portrait lenses so arranged by means of cords and pulleys neatly fixed to the camera that the diaphragm and the diffusion of definition can be controlled by the photographer from the back of the camera while he is looking at the image on the focussing screen. The firm will be glad to send further details of the above on application to them.

Received. A new catalogue of photographic goods from Messrs. Marion and Co., Soho Square. Besides the usual apparatus and materials the list includes ferro-prussiate papers and linen for copying plans, apparatus for its use in sheets up to the largest sizes, an electric printing machine, and many other pieces of apparatus not usually catalogued. A special feature is the "Soho" reflex hand camera, which has the movement of the mirror so arranged that lenses of very short focal length can be used when required, and a lengthening tube that may be attached gives an extension of twenty inches, so that practically any size of image may be obtained when a small telephoto lens is employed.

Rapid Telegraphy.

M. DESIRÉ KORDA contributes to the *Journal de Physique*, No. 253, a short account of the Pollak Virag system of rapid telegraphy. In the transmitting apparatus of this system, a perforated paper roll, containing the message passes over six rings, each maintained at a different potential and the current is taken up by brushes, which make a connection every time that a perforation passes under them. These brushes are connected three and three in parallel. In the receiving apparatus, the currents act on two telephone membranes, which impart horizontal and vertical motions to a small rotating mirror, by which a beam of light is reflected on to a slip of sensitised paper. The combination of these motions produces characters in ordinary writing somewhat suggestive of the curves in Lissajou's figures. An apparatus based on this principle formed the subject of experiments between Berlin and Budapest, in 1900, but only one telephone was used, the messages taking the form of undulations of various heights. The present use of two telephones enables the use of characters resembling ordinary writing. The apparatus is capable of transmitting 400 signals per second, a speed which gives it a considerable advantage over other writing telegraphic apparatus.

Practical Aerodynamics and the Theory of Aeroplanes.

By MAJOR B. BADEN-POWELL.

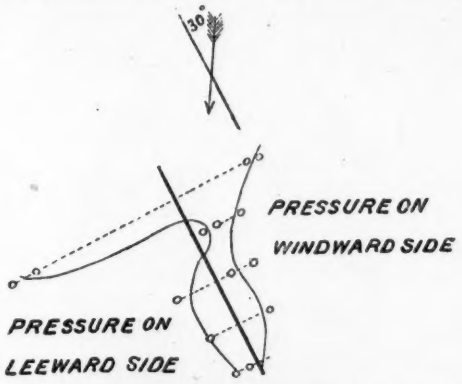
IX.—THE LEE SIDE OF AN INCLINED PLANE.

IN considering the theoretical principles of the pressure of air on an inclined plane, the re-action that takes place on the lee side is often forgotten. If a thin lamina or plane without appreciable thickness be experimented upon, the resulting pressure may be very different to that affecting a solid body with an inclined face. As an instance, if a penny be fixed to incline at an angle of 45° and is exposed to a horizontal current of air, the pressure will be greater than is experienced on the end of a pole sawn through at the same angle and exposing an equal area. As we have already seen (p. 104), the current of air flowing horizontally all round the periphery sucks away the air from behind the thin plane, and this suction or lack of pressure has to be added to the force of the air impinging on the exposed surface.

This effect may easily be demonstrated experimentally by the following apparatus:—

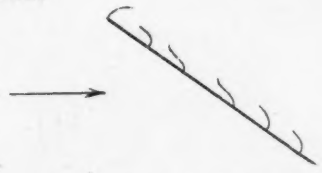
AD is a rigid plane, such as a stiff piece of cardboard. B is a light sheet of paper, slightly curved, affixed to the back of the plane at its front edge. When a current of air, C, is directed against this, the paper rises up into the position AB′. This action is the more pronounced as the angle of A with the current is increased. In fact, the direction of AB′ remains about horizontal, whatever the inclination of AD may be.

Dr. Stanton found that with such inclined planes there was a very considerable lack of pressure immediately behind the leading edge, but he also found



that this pressure fluctuated very greatly, the variation amounting to as much as 50 per cent. above or below the mean value, when the inclination was about 10°.

Another curious result is, that the air drawn in to fill the partial vacuum flows up the back of the plane towards the front edge. This may be demonstrated by pasting the ends of a number of small strips of tissue paper on the back of the plane, the other ends being free to be blown by the wind in whichever direction it may be moving. Then, at all events when the inclination is over 30°, the papers will turn upwards and bend over towards the leading edge of the plane, showing that the current is deflected around so as to flow up the back of the plane in nearly the opposite direction to its original flow.



If an apparatus be constructed with a series of planes, one behind the other, each inclined at an angle so that the air strikes on its under surfaces, it is easy to suppose that the apparatus will be supported on the air. But it will also be found that if the surfaces be turned till they incline downwards and only present their upper sides to the air when travelling horizontally, there will still be some action of support derived from this forward flow of air along the back.

This has an important bearing on a matter which will be further gone into in considering the action on curved surfaces.

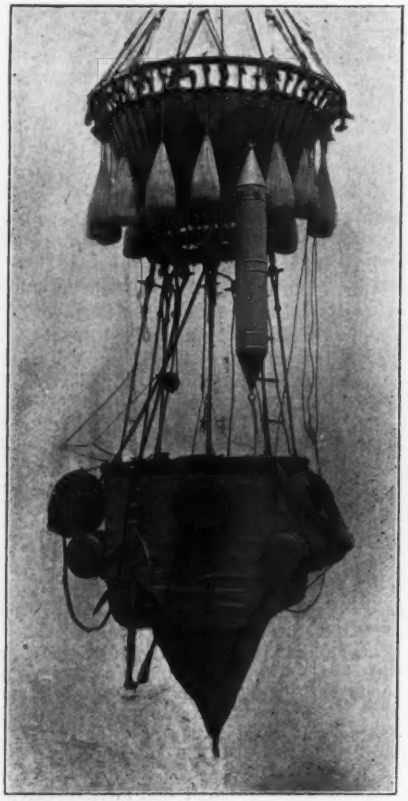
Aëronautical Notes.

Long-Distance Ballooning.

THE attention directed to dirigible airships has re-awakened interest in long-distance ballooning, but sufficient attention has not, we think, been given to the voyage of the "Mammoth" balloon, which, starting out from the Crystal Palace on Saturday, October 12, reached the shores of Lake Wener, in Sweden, next morning, a distance of 702 miles. The voyage set up a new record for the distance travelled over sea, but the remarkable feature of the journey was that when the balloon descended it would have been quite possible to have continued the voyage for a period considerably longer than that over which it had already extended. According to Mr. C. C. Turner, who kept the log of the "Mammoth" and made the meteorological and other observations incident to the voyage, the balloon had lost none of its lifting capacity after its fourteen hours' journey, and was quite capable of travelling an additional 2,000 miles had the aëronauts been satisfied that the wind was taking them in the desired or a desirable direction. Originally it had been intended to leave England with a westerly wind, but a long period of enforced inaction during the calm weeks of September induced the aëronauts, Mr. A. E. Gaudron, Mr. Tannar, and Mr. Turner, to accept the chances of a wind rather south of this (S.S.W. to W.S.W.), although they were quite aware that such a wind would probably take them too far north. As far as can be determined, they were taken by this current from Yarmouth, on the English East Coast, across the North Sea to Denmark. They were then caught in a northerly current and swept across the Scaw to Scandinavia, again crossing the sea, and shortly afterwards lost their bearings owing to a dense bank of clouds below them. On descending through this blanket they found themselves drifting towards the shore of an angry expanse of water, which they did not recognise as a lake owing to its extent, and which they suspected of being either the North Sea or the Baltic. There was nothing left for it but to make an immediate descent, for the wind had increased in force, and they could not tell where it was taking them.

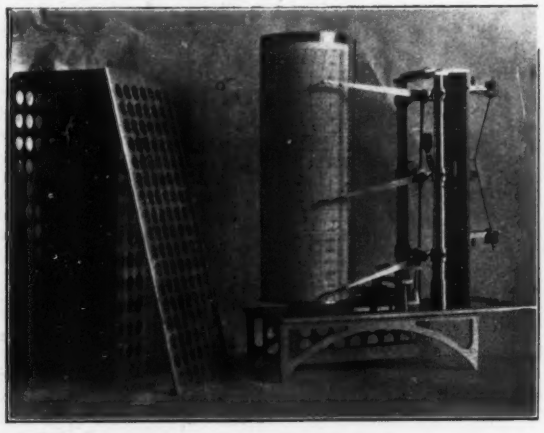
From Mr. C. C. Turner's log we learn that the exact time of leaving Sydenham was 6.25 p.m. (Saturday, October 12). Land was left at 11 p.m. on the same night, and was once more sighted at 8.20 a.m. Sunday, October 13, the wind having then veered from S.W. to W.S.W. The nearest point was Sonderrig, Denmark. Two hours later the balloon was close to the sea near Hadsund, east of Aalborg. The balloon had thus travelled very rapidly across Denmark in an E.N.E. direction. The wind now suddenly backed to the south, 10.55 a.m., and about 11.40 a.m. the aëronauts

had a brief glimpse of land to the north. The height of the balloon while in England was from 3,500 to 4,500 feet. Over the North Sea it gradually rose from 4,500 to 8,300.



The double-decked car of the "Mammoth" balloon.

It continued to ascend over Denmark, and between 8.20 a.m. to 11.20 a.m., when the aëronauts caught sight of the white line of foam which marks the meeting of the North Sea and



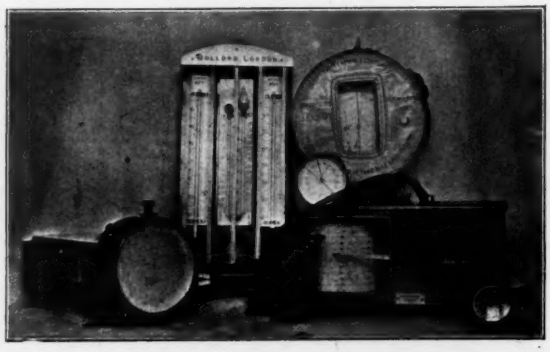
Special recording instrument used on the voyage.

the Baltic to the N.W. of Scaw Point, the balloon rose from 8,300 feet to 11,000 feet. The greatest height attained was 11,350 feet above Sweden, and the descent from 11,000 feet through the curtain of cloud to the ground was made in half a minute. Only 30 lbs. weight of the ballast was used.

We are indebted for the following notes to Mr. C. C. Turner himself.

The Voyage of the "Mammoth."

"We set out upon the journey well provided against every danger. We were provisioned for over a week. The basket of the balloon was water-tight besides being provided with air-tight floats. We also took lifebelts, coloured flares, and a sea anchor. That none of these appliances had to be used matters not. We should take them again for any similar



Thermometers, hygrometer, and other instruments used

venture. For a longer oversea voyage—crossing the Atlantic, for instance—it would be necessary to have a car in the shape of and possessing the same seaworthy qualities as a lifeboat.

"In the 'Mammoth's' journey Mr. A. E. Gaudron introduced to the practice of ballooning a number of appliances and instruments due to his own inventive ingenuity. The journey was, in many ways, a pioneer journey, and it may well serve as a basis upon which other long-distance balloonists may build.

"One direction in which Mr. Gaudron strove was in reducing the labour and constant watchfulness necessary. To keep alert and properly to observe the phenomena of the upper air the balloonist must be in as little anxiety as possible. The mechanical sand-thrower proved in this journey to be a great boon. With its aid the quantity of sand discharged can be regulated to a nicety, while as much

Mr. C. C. Turner.

as 170 lbs. can be dropped in a minute. Every balloonist knows the heavy labour entailed by the rapid manual discharges of ballast, a wasteful process and one that often leaves the aëronaut exhausted.

"Of even greater importance was the audible signalling aneroid, an ingenious instrument of far greater utility than the statoscope, which, indeed, it supersedes. The statoscope requires the personal attention of the balloonist. It has to be manipulated before its sensitive needle shows whether the balloon is ascending or descending. But in the signalling aneroid of the 'Mammoth' we could leave all anxiety to the instrument. It required no attention. At any approximate altitude we chose to remain in we could set its dial, and then, whether we went 250 feet higher or 250 feet lower a little bell rang out a warning.

"We found this instrument, which was made by Messrs. Dollond and Co. from a specification supplied by Mr. Gaudron, most efficient. It is certainly one of the most important ballooning instruments ever devised.

"The water-floater, which serves in the sea the same purpose that the trail rope serves on land, represents another important improvement. It is a cylinder fitted in airtight compartments, and a central chamber for water. It is buoyant when the water chamber is full. As it is lifted out of the water its weight depends more and more upon the balloon, whose ascensive force is thus automatically checked. On the other hand, as the balloon descends, the weight of the floater is put back on to the sea, and the balloon is automatically relieved. From the car of the balloon the floater can be tilted and emptied of its water.

"Major Hermann Moedebeck, of the German Army, sums up the rules for prolonged voyages as follows:—

"'The inflated balloon must be held as low as possible at the ascent. It must be kept out of the influence of the sun's radiation as long as possible. It must be kept as much as possible floating in cloud strata. The valve should not be opened, nor ballast thrown except for necessity.'

"To these must be added the elementary rule that it is necessary to keep the balloon at an even altitude so as to prevent the expansion and waste of gas, and the contraction of gas and loss of ballast.

"The great value of the water-floater is now apparent, and the reason for making the ascent at sunset, when the aëronaut has 9 or 10 hours of almost unvarying temperature before him, is also clear.

"The meteorograph, giving automatically-recorded temperature, altitude, and humidity, is probably a familiar instrument to readers of 'KNOWLEDGE.' If it could be made slightly less fragile, even with the addition of a few pounds to its weight, it would be more suitable to the aëronaut.

"By night the balloonist requires, above all things, a compass easy to read. If any of our scientific instrument makers can devise a compass with a steadier needle, and one, moreover, with two extending arms, by which the observer could easily take a line east and west, they will be doing good service to ballooning.

"For a long-distance balloon voyage you must have a large balloon. The larger the balloon the greater is your margin of weight-carrying capacity, the greater your power to overcome the effect of rain or heavy dew or ice on your aërostat.

"Fragile though it looks, the balloon is marvellously suited to its element. Looking back at our swift descent of 11,000 feet in 30 seconds, I marvel that the aërostat withstood the strain. Yet upon reflection I do not marvel. The swift descent and the sudden, purposeful check at the finish belong to the science of ballooning. And not a bit less does the sagging up of the envelope as the gas escapes, making the base of the balloon like a parachute, enter into the calculations of the skilled aëronaut. It is a matter for wonder to the average man, because skilled aëronauts are not so plentiful as skilled motor-car drivers. Yet, in his sphere, the motor-car driver has problems to solve, and truly solves them, which are not less wonderful because they happen to be more familiar to us."

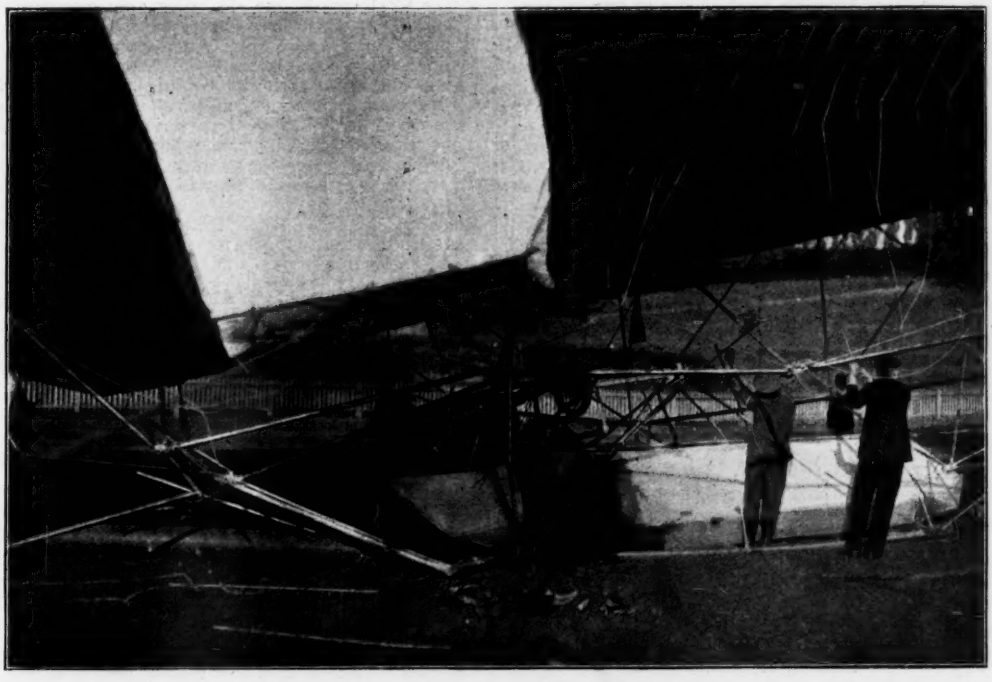


Photo by Russell and Sons.] **View of damaged front aeroplane.**

The Accident to the Military Airship.

Little can be said now about the preparations which are being made at Aldershot to replace the "Nulli Secundus." Her voyage to London on October 8 gave opportunity for the most extravagant anticipations on the part of the

writers in the lay press as to the new era in aëronautics which was heralded by the performance, and these anticipations were followed by reactionary denunciations when a series of mishaps made her first long voyage her last. As regards the performance of the "Nulli Secundus," it may be said that it is the best ever accomplished in England, and is, with one exception, the only serious attempt to vie with the experiments which have been made in France for nearly a quarter of a century, and in Germany for the last ten years. The airship could not get back to Aldershot, and, owing partly to an insufficient lifting capacity, seemed incapable of stemming a head-wind of moderate strength, but, on the other hand, the "Nulli Secundus" was successfully steered, and in that sense, at any rate, showed herself to be a genuine "dirigible." It was in several senses unfortunate that the severe wetting she received after mooring at the Crystal Palace made it impossible for her to take advantage of at least one favouring wind for a return to Aldershot, and the accident which wrecked part of her framework, while she was tethered (as shown in our photograph), seems destined to show that dirigible airships are at present very ill-fitted for the rough and tumble of war. The only logical inference from the many accidents that have happened to airships is that if they are to be a military asset they will have to be constructed on so large a scale, and with such a very great lifting capacity, that they may be made of very much stronger materials than at present. In the view of the present writer the Zeppelin type, which applies the canon of strength even to the balloon part of the apparatus, is more logical than the flexible goldbeater-skin type, however stiffly and ingeniously that may be supported.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.Sc.

Comet 1907 e. (Mellish).

A TELEGRAM from the Centralstelle at Kiel announced the discovery of a new comet by Mr. Mellish at Madison, U.S.A., on October 13. Its magnitude at discovery was only 9.0, but it appears to be rapidly increasing in brightness. The following elements and provisional ephemeris have been computed by Miss E. Lamson at Washington.

τ = 1907 Sept. 12·47 G.M.T.
ω = 291° 42′
Ω = 55° 32′ } 1907·0
i = 118° 53′
q = 0·973

EPHEMERIS FOR 12h G.M.T.

1907.	R.A.	Decl.	Brightness.
	H M S		
October 19	8 14 4	− 7° 0′	1·15
,, 23	7 57 41	−4° 38′	
,, 27	7 36 1	−1° 30′	
,, 31	7 6 49	+2° 39′	2·06

The extension of the ephemeris into November is not yet available, but the place of the comet may approximately be found by plotting the above and continuing the curve. The comet is moving in a north-westerly direction through the constellations Monoceros and Orion, and should be watched for in the early morning after about 1 a.m.

Spectrum of Comet 1907 d. (Daniel).

The spectrum of this comet appears to have been especially well observed at various stations. Monsieur H. Chrétien obtained photographs at the Nice Observatory by means of a prismatic camera with an objective prism during several nights in July and August last. The apparatus comprised an objective of 10 cm. aperture and 47 cm. focal length, with a large prism of 62° angle set at minimum deviation for the blue part of the spectrum at G (λ 4341), the whole being mounted on the 38 cm. equatorial and so oriented that the edge of the prism was parallel to the tail of the comet. Lumière Σ plates were employed, and for comparison the spectrum of Capella was photographed on the negatives. Exposures on the comet spectrum varied from 60 to 105 minutes.

A list of the spectrum lines found is given, from which it appears that the chief lines in the spectrum of the tail were 4016, 4267, and 4522, each of these being distinctly double.—(*Comptes Rendus*, 145, p. 549, September 23, 1907.)

Monsieur J. Bosler describes the results which he obtained with a two-prism slit spectrograph at the Meudon Observatory. An image of the comet was formed on the slit by means of an objective of 4 inches aperture and about 17.6 inches focal length, the slit being adjusted parallel to the tail of the comet. Three photographs were obtained on the nights of August 8, 18, and 19 with exposures of 40, 60, and 70 minutes respectively, Lumière Σ plates being employed. For comparison spark spectra of iron with capacity and self-induction were photographed on each plate. The spectra show the usual hydrocarbon series, with two bands of cyanogen and several strange bands of unknown origin. Their wave-lengths are as shown below.

Wave Length.	Intensity.	Origin.	Wave Length.	Intensity.	Origin.
4948	1	Unknown.	4411	?	Unknown.
4811	1	Unknown.	4389	1	Hydrocarbon 4382
4733	2	Hydrocarbon 4737	4364	?	,, 4365
4712	3	,, 4715	4314	1	Unknown.
4693	4	,, 4698	4250	1	Unknown.
4678	3	,, 4685	4215	2	Cyanogen 4216
4606	?	Unknown.	3883	2·5	,, 3883
4544	1	Near new hydrogen	3870	1	,, 3871

These lines are only shown in the spectrum of the nucleus and head, that of the tail not being obtained. It is noticeable that the cyanogen bands are stronger than the blue bands of hydrocarbon, but it is possible that this may be due to the colour of the prisms, as it is contrary to the effect found by MM. Deslandres and Bernard with the objective spectrograph ("KNOWLEDGE," October, 1907).—(*Comptes Rendus*, 145, p. 582, October 7, 1907.)

Physical Nature of Meteor Trains.

Meteor trains are the luminous cloud-like forms seen after the flight of a meteor, which usually persist some time after the incandescent nucleus has disappeared. Professor C. C. Trowbridge has collected most of the evidence given by past observers, and discusses the data with the object of deducing information concerning the physical constitution of the upper atmosphere. It is found that meteor trains seldom, if ever, occur at altitudes below 45 miles or over 65, the usual height being 50-60 miles (80-100 km.). In this zone there appear to persist certain conditions favourable to the production of luminous meteor trains. As we know that the most important condition of a gas respecting the production of electric discharges is its pressure, it seems possible that the suitable degree of rarity is present at the above-mentioned altitude.

As many of the observed trains were visible for ten or twenty minutes, the phenomenon may be regarded as a gas luminescence, and this view is supported by the three facts—(1) the rapid lateral diffusion amounting to as much as 100 metres per minute; (2) the great volume contained within the boundary of the train, usually several cubic miles; (3) the observed spectrum consisting of a few bright lines. Moreover, the rate of decay of the glow appears to be nearly the same as is found in laboratory experiments, especially in the case of the electrodeless ring discharge.

Another characteristic feature of the meteor train, its dual appearance, may be explained by regarding it as a tube of luminescent vapour, practically along the axis of the path

taken by the meteor. Other interesting peculiarities which are discussed fully are the diffusion of the train and the evidence of atmospheric drift at high altitudes. In some cases there is evidence of the existence of zones of colour 5-10 miles in depth, bordered by swift air currents.

Professor Trowbridge concludes that—

(1) The meteor trains are self-luminous gas clouds, combined with very minute meteoric dust particles, the latter in daylight reflecting ordinary daylight like ordinary clouds.

(2) The height of meteor trains seen at night appears to be at a definite altitude, indicating that the phosphorescence is dependent on the gas pressure where the trains are formed.

(3) The diffusion of the train is gas diffusion, and its rate depends on the pressure and temperature of the atmosphere, and also probably on the initial intensity of the train.

(4) Many meteor trains appear to be tubular in form, that is, the luminosity is greatest near the border, giving a dual appearance.

(5) The colour, diffusion, and spectrum all indicate that the phenomenon is similar in character to the after-glow following the electrodeless ring discharge.

Temperature of Mira Ceti and Sun-Spots.

Father Cortie, writing in the *Astrophysical Journal* for September, 1907, discusses the variability of the light of Mira Ceti in relation to the evidence it furnishes with regard to the relative temperature of sun-spot vapours. Observations made during past years have indicated that the flutings seen in the red region of sun-spot spectra show the existence of gaseous compounds as distinct from elements, and, according to this view, sun-spots are at a lower temperature than the neighbouring photosphere. Hale and Adams have identified bands in the deep red region as due to titanium oxide, and Fowler has traced a series of bands in the green due to magnesium hydride. If, then, we argue from the differences in the spectra of stars which are generally assigned to temperature, as in α Herculis, and α Orionis, we can connect these spectra with that of Mira Ceti at various stages of its light period. Two recent maxima of Mira have been very different in extent, that of December, 1906, being at least a magnitude brighter than that of 1897. A comparison of the two series of plates of the spectrum of the star, under precisely similar conditions as to plates and instruments, shows a striking change in the relative intensities of the bands. When the star was brightest, and, therefore, probably hottest, there was a marked decrease in the intensity of the titanium oxide bands. Other notable variations were seen in the hydrogen lines. Hence the undoubted presence of the chief constituents of the line spectrum of sun-spots as intensified in stars of Group III.; the presence of bands of titanium oxide; the partial disappearance of some of these bands, and the total disappearance of others at the greater luminous maximum of Mira Ceti in 1906; the special behaviour of the hydrogen lines similar to that observed in new stars; the substitution of a line for a banded spectrum in a series of stars on an ascending scale of temperature, are all facts which, taken collectively, point to the conclusion that the temperature of sun-spots is lower than that of the solar photosphere.

BOTANY.

By G. MASSEE.

Botanical Survey of Kapiti Island.

KAPITI ISLAND is situated in Cook Strait, between the North and South Islands of New Zealand, and lies about three nautical miles from the North Island. It is a remnant of the ancient land bridge which connected the North and the South Islands. Kapiti is one of three islands situated at different points of the New Zealand coast that have been dedicated by the New Zealand Government as sanctuaries for plant and animal life. An official report on a botanical survey of the island has just been prepared by Dr. Cockayne.

The flora is closely related to that of the neighbouring mainland of Wellington, on the one hand, and Marlborough on the other, but the forest itself, like that of small islands generally, possesses certain peculiar forms and combinations. Usually the forest is very low, but a true forest, nevertheless, if the presence of trees with distinct trunks is the criterion; in many places the trees pass into shrubs, and a scrub-forest results. The forest is of the mixed type, and of a costal character, *Macropiper excelsum*, *Corynocarpus laevigata*, and a species of daisy tree, *Olearia forsteria*, being present in large quantities. The plants playing the leading part in the physiognomy of the forest are those of the central botanical province of New Zealand. Lianes are a pronounced biological group; many of these show more or less marked heterophylly. *Lomaria filiformis* is the most interesting fern, characterised by a most striking heterophylly, the extreme leaf forms being so very different that to a stranger it is difficult to believe that they can belong to the same plant. Other kinds of ferns also show remarkable dimorphism.

The scrub formation has arisen where the forest has been removed by fire or otherwise, and where the costal heath is open there is a grassy floor where Yorkshire fog, *Holcus lanatus*, and other low plants are abundant.

In swampy ground such European plants as *Typha angustifolia*, *Juncus effusus*, and *Scirpus inundatus* are present. The birds are very numerous, and for the most part very tame. The scientifically interesting invertebrate, *Peripatus*, is quite common.

Notwithstanding its remoteness, Kapiti shelters a considerable number of European plants and animals; among the latter may be enumerated cats, goats, cattle, sheep. An endeavour will be made to rid the island of these aliens. Their presence is mostly due to the fact that Kapiti was a famous whaling-station during the early part of the last century.

Structure and Relationships of Potamogetonaceae and Allied Families.

Certain features of the structure of *Potamogeton*, hitherto apparently overlooked, are described in detail in *Bot. Gazette* by Mintin Ashbury Chrysler. The primary object of the research was to throw some light on the origin of the monocotyledons. It is generally admitted that those monocotyledons possessing a root-stock or bulb have become so specialised that they are less favourable for a study of primitive features than those plants possessing an elongated axis with distinct nodes and internodes. The *Potamogetons* possess the latter type of structure, and have been considered as representing certain stages in the evolution of aquatic monocotyledons from ancestors growing in marshes. On the other hand, it has been suggested that monocotyledons have descended from dicotyledons through adaptation to an aquatic habitat.

Admitting that monocotyledons are derived from dicotyledon-like ancestors, the author considers *Potamogeton* to be the most primitive genus known, for the following reasons: The stem is not a shortened axis, as in most other monocotyledons. Xylem is well developed in the nodes, floral axis and young stem in many species of *Potamogeton*; its presence in these regions cannot be explained from a physiological standpoint, hence must be regarded as an ancestral relic. The circle of bundles in the floral axis is more distinct than in any of the allied genera studied, with the exception of *Triglochin*, but in the last-named genus the rhizome has probably been shortened and thickened in accordance with its geophilous habit. The inflorescence is a spike or spadix, an admittedly primitive type. The course of the leaf-traces in *Potamogeton* is not that of a typical monocotyledon.

The cortical bundles, when present, are not considered as primitive structures, but have arisen in connection with mechanical necessities.

Halophytism.

Professor Casu has announced in the *Annali di Botanico* the results of his study of the sea coast flora at Cagliari. Three features appeared to depend on the presence of marine salts present in the soil. (1) Dwarfing and sporadic occurrence; (2) prevalence of herbaceous over woody plants, both in species and numbers; (3) constant presence of certain species growing in contact with marine salts in solution.

XUM

A careful study has led the author to the conclusion that those marked features indicated above are not in any way dependent on either the toxic or the nutritive value of the salts, but to physico-chemical conditions more or less influenced by the presence of the salts.

The prevalence of herbaceous forms and of dwarfing is due to impoverishment of the soil, and not to the percentage of salts in contact with the roots.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

The Dangers of Ferro-Silicon.

A HARD useful alloy, known as ferro-silicon, is prepared by heating together in an electric furnace quartz, coke, lime, and an iron ore, the resulting product containing from 60 to 80 per cent. of silicon, with 17 to 37 per cent. of iron, and small amounts of other substances such as aluminium, calcium, phosphorus, and arsenic. The alloy is broken into lumps and packed in iron drums or casks for transport, and it is then that the greatest risk occurs in connection with its use. Certain kinds of ferro-silicon are readily disintegrated on contact with water, and numerous accidents have taken place through the explosion of the gases thus liberated. For instance, in 1904, a series of such explosions occurred in casks of recently imported ferro-silicon, which had been left for nearly a month upon the quay at Liverpool, and the cause of these was attributed by Mr. Watson Gray to the presence of calcium carbide in the alloy, and its decomposition by moisture. Later in the same year several drums of ferro-silicon exploded after removal from the wharf to a warehouse in Bootle. In this case it was found by the late Dr. Dupré and Mr. B. Lloyd that the lumps of material when moistened with water gave off a gas consisting in the main of phosphuretted hydrogen, and that this could form an explosive mixture with the air left in the casks. The cause suggested for the ignition of this explosive mixture was the heat generated by the friction of the lumps of alloy against the sides of the drums, or, possibly, the spontaneous ignition of a quantity of phosphuretted hydrogen suddenly liberated from a "pocket" by the fracture of a lump. As a remedy, it was suggested that the casks should be filled up with paraffin oil of high flashing-point, or that the ferro-silicon should be treated with water until no further reaction took place before being packed. In addition to the risk of explosion, the transport of ferro-silicon often involves the further risk of poisoning those who may be exposed to the gases liberated from it on contact with moisture. Several deaths occurred last year on Rhine boats from this cause. In one of these cases, investigated by Herr Lehnkering, two children lost their lives through sleeping in a cabin above the hold in which the casks of ferro-silicon were stored. The alloy had been exposed to the rain for 5 or 6 days, and the gases thus evolved had found their way through the floor of the cabin and poisoned the children. When examined, it was found to contain 57.69 per cent. of silicon, and 0.15 per cent. of phosphorus, and on contact with water still gave off 0.0227 gramme of phosphuretted hydrogen per kilo. It was concluded that the phosphorus was in combination with calcium, since iron phosphide is not decomposed by water. In a still more recent instance, four passengers on a Swedish steamer died mysteriously, and here again it has been found by Professor Cronquist, of Stockholm, that their death must be attributed to the poisonous gases given off by ferro-silicon stored in the hold beneath the cabins. The proportion of silicon in the alloy does not appear to have any influence on its decomposition by moist air, for certain kinds containing up to 80 per cent. of silicon remained unaltered for weeks. The dangerous constituents are the small quantities of unstable compounds of phosphorus and arsenic, and every precaution should be taken to have the material in an absolutely dry condition when packed, and to prevent the slightest trace of moisture gaining access to the vessels containing it.

The Characteristics of Horse Fat.

The fats derived from different species of animals show remarkable differences, and this is also true of the fat taken from different parts of the same animal. Thus in the sheep the fat surrounding the kidneys is remarkably hard, whereas the fat from the neck and breast is nearly fluid; and this physical difference corresponds with a difference in chemical composition. Animal fats consist, in the main, of compounds of glycerine, with two solid, fatty acids, known as palmitic and stearic acids, and two liquid, fatty acids—oleic and linolic acids. The hard, solid fats contain a larger proportion of stearic acid, which melts at a high temperature, while the more fluid fats contain more of the liquid fatty acids, notably oleic acid. As the latter are unsaturated compounds they can be made to combine with iodine, and the percentage of that element absorbed affords a rough measure of their proportion in a given fat. For instance, pig's fat absorbs from 45 to 65 per cent. of iodine, and hence consists approximately of 50 per cent. of the glycerides of liquid fatty acids. As a rule the fat from the kidneys of animals is characterised by a low iodine absorption, and a high proportion of stearic acid, but the kidney fat of the horse forms a curious exception to the rule, for it is liquid, has a very high iodine absorption, and is devoid of stearic acid. It was found some years ago by Mr. Otto Hehner and the writer that that acid was not present in horse fat, and their results have recently been confirmed by Mr. H. Dunlop, who has examined specimens of the fat from different animals. In each case the fat, from whatever part it was taken, was of a light yellow to orange colour, and of liquid or semi-solid consistency. It possessed the curious characteristic of drying to form a solid varnish when exposed in a thin film on glass, and in this respect was more akin to the vegetable drying oils, such as linseed or walnut oil, than to ordinary animal oils or fats. Hitherto the only animal fats that have been found to possess similar drying properties are those of certain wild animals and birds.

Alcohol From Peat.

The general principles of the methods of obtaining alcohol from peat have already been described in these columns ("KNOWLEDGE," this volume, page 65). Since then M. R. Pique has published the results of experiments on an industrial scale made in France. From these it appears that the amount of water in surface peat is about 80 per cent., and that it decreases to about 44 per cent. in peat taken from a depth of one to two metres. There is, however, a similar decrease in the proportion of pentosans and cellulose as the depth increases, so that, as a rule, peat taken at a depth of one-half to one metre is the most suitable for the manufacture of alcohol. With regard to the yield of alcohol, the best results were obtained by saccharifying the peat with dilute sulphuric acid and fermenting the expressed liquid by means of a vigorous race of yeast previously acclimatised to an acid liquid. In this way 10 litres of absolute alcohol were obtained from 100 kilos. of the dry substance of the peat. The residue, when dried and compressed into briquettes, formed an excellent fuel.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

Black Sands of the Pacific Slope.

THE *American Journal of Science* records the analyses of a large number of specimens of the Black Sands of the Pacific Slope. These were supplied by placer miners at different points. The examination of the samples received has shown that the following minerals, in the order named, are most commonly found in these sands:—Magnetite, gold, ilmenite, garnet, zircon, hematite, chromite, platinum, iridosmium, mercury, amalgam, olivine, and iron silicates, pyrite, monazite, copper, cinnabar, cassiterite, and corundum. Other heavy minerals, are only exceptionally found.

With respect to the occurrence of platinum, information

with regard to which was the primary object of the undertaking, the following statement is made: "Platinum was found in 120 localities. The investigation showed that the largest field of platinum, and the most profitable field for commercial exploitation, is comprised in Coos, Jackson, Curry, and Josephine Counties, Oregon, and in Del Norte, Siskiyou, Humboldt, and Trinity Counties, California. Outside of this region platinum is also found to a notable extent in Plumas and Butte Counties, Cal., and, although the proportion of platinum per cubic yard of gravel is not so great, the large dredging operations in Butte County make this an important locality. Platinum was also found occasionally on the Snake and the Columbia rivers and on various beaches of the Washington coast. It was found in place in chromite near Anacortes, Wash., as well as at the previously known locality, the Rambler mine, in Albany County, Wyoming.

By the use of careful concentration methods it has further proved possible to separate gold and platinum from the sands with comparative ease.

Imperial Seismology.

In a country in which earthquakes are of such frequent occurrence as in Japan, it is desirable that all available information bearing on the subject should be rapidly brought to the notice of the people, especially in regard to warnings as to possible future activity. The Imperial Earthquake Investigation Committee has, therefore, inaugurated the publication of an official Bulletin, which is to be the medium of conveying to the public short notes and interim reports on subjects of urgent importance.

Greenland Minerals.

A summary of the interesting occurrences of rare minerals on the south-west coast of Greenland, and at other places on that Continent, has been prepared by Dr. O. B. Boggild, and published under the title of *Mineralogia Groenlandica*. Much information is given in respect of the cryolite locality at Ivigtut, and the fertile region around Disco, with its wonderful supply of telluric iron. There is also a useful geographical list of all the Greenland localities, with a coloured map.

METEOROLOGY.

By W. MARRIOTT, F.R.MET.SOC.

The Recent Weather.

THE bright and warm weather which prevailed throughout September helped to redeem the character of the summer, and to make some amends for the previous cold and gloomy months. Crops in many places ripened rapidly, and most of the harvest was gathered in under very favourable conditions.

The weather after the first few days was of a settled anti-cyclonic type, and as a consequence there was almost an entire absence of rain after the 6th. Over a large part of the country there was a "drought" of from 20 to 25 days' duration. The amount of rain which fell during September was unusually small over the whole country; in fact, over England and Wales the total rainfall was under three quarters of an inch.

The weather during October was in marked contrast to that experienced in September. During the early part of the month a number of small cyclonic disturbances passed over Spain and the South of France, and were accompanied with very heavy rainfall, which produced serious floods and caused loss of life and destruction of property. Subsequently a number of small cyclonic disturbances passed over the British Isles mostly in a northerly direction, and these were also accompanied with heavy rains, which caused floods in many districts.

The Nile Flood of 1906.

The series of seven dry years which began with the exceptionally low flood of 1899, when the volume discharged by the Nile was 37 per cent. below the average, and ended with that of 1905, which was 35 per cent. deficient, was succeeded in 1906 by a flood which was more nearly of average volume.

Capt. H. G. Lyons, F.R.S., the Director of the Egyptian Survey Department, says that year by year it is possible to supplement existing information by newer and more ample data, and to fill gaps in the chain of conditions which lead up to the summer rains of Abyssinia, the feeders of the Nile flood. A few years ago the resemblance between the gauge curve of a rising flood and that of some former year was used as the only means of anticipating its probable development; then it was suggested that the Bombay rainfall might be utilized as a basis of prediction, but with the re-opening of the Soudan and the establishment of meteorological stations there, supplemented by others in the equatorial regions, our knowledge has rapidly increased, and deductions from accurate observations have largely replaced empirical methods. To-day it is possible to follow the northward extension of the rains of tropical East Africa from Mauritius and Zomba, in British Central Africa, which lie just within the southern tropic, through German East Africa up to the lake plateau. In the Seychelles Islands of the Indian Ocean and in British East Africa and Uganda, they are noted as they pass on to the Somali Coast, and to the Bahr el Jebel. Further north again, a chain of meteorological stations now supply full information about the intensity and the extension of the rains from the Nile-Congo watershed through the Bahr el Ghazel, and along the Bahr el Jebel and the Sobat, across the Sudan plains to the limits of the Monsoon region near Dongola and Berber; but to the south of the Abyssinian table-land information is still meagre.

The Nile presented several features of special interest during 1906. In both February and March heavy rainstorms occurred in Abyssinia and the Southern Sudan, which raised the river levels and greatly improved the low-stage supply of the spring months; the steady improvement in the rainfall of August and September furnished a flood about 10 per cent. below the average, while the maximum gauge readings at Wadi Halfa just exceeded the mean, a great improvement on the conditions experienced during the past seven years.

"Dust Devil."

An unusually good specimen of what is popularly known in the East as a "dust devil" was observed by Mr. J. B. M. Ridout, of the Survey Department, Colombo. It is described in the Report of the Surveyor-General of Ceylon as follows:

"It was about 12.30 p.m., that I was at the corner of this block opposite the Fort station, when I first saw it. It was then to the north side of Norris Road, just on the Fort side of the Racquet Court, the appearance it presented being a rough, vertical column of dust about 30 feet high, perhaps 4 feet in diameter at the top and where it touched the ground, and 8 feet at a height of 3 feet from the ground. It was revolving rapidly in the reverse direction to the hands of a clock when looked at from above. It lasted about three minutes, and moved along the road in the direction of the Fort, finishing in the corner at the north-east end of the Fort station, where the posts carrying the telephone wires are. It was then about 40 feet high, being, except just at the bottom, in the form of a column about 2 feet in diameter with perfectly smooth sides, and at the top the dust was rising just like the smoke from a chimney. It was still perfectly vertical except the top ten feet or so, which were inclined to the south. At the bottom it bulged out, being about 3 feet in diameter where it touched the ground, and 4 or 5 feet at 3 feet higher; in fact, the whole column was in shape very much like the glass of an enormous thermometer. At the end of the Fort station it disappeared; whether the currents of air were broken by the roof of the station, the tree, and the telephone posts, or whether it faded away because there was no dust on the railway line for it to pick up, I do not know, but I am inclined to think that the former is more probable, as I went at once on to the railway platform but was unable to detect any disturbance either on the permanent way or on the surface of the lake."

XUM

I should have gone to see what sort of a track had been left on the road but could not as my train was due.

"The wind at the time was practically nil, what little there was being north-east."

Symons Gold Medal.

The Council of the Royal Meteorological Society have awarded the Symons Gold Medal for 1908 to Monsieur L. Teisserenc de Bort, of Paris, in recognition of the services which he has rendered to the science of meteorology.

The medal was established in memory of the late George James Symons, F.R.S., the founder of the British Rainfall Organization, and is awarded biennially. The presentation will take place at the annual general meeting of the Society, on January 15.

Lectures on Meteorology at the University of London.

A course of twelve lectures on "Meteorological Organisation and Methods of Dealing with Meteorological Observations." will be given on alternate Mondays, at 5 p.m., at the London University, South Kensington, commencing on October 21, by Dr. W. N. Shaw, F.R.S., the Director of the Meteorological Office. The lectures will be addressed to advanced students of the University and to others interested in meteorology. There is no fee for the course, so the lectures are open to all who like to attend.

ORNITHOLOGY.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Unsuspected Breeding Birds.

IT would seem that while most of us have looked upon the blue-headed wagtail as one of the rarer British birds, it has all along been breeding in our midst, unsuspected, because so like in general appearance to the yellow wagtail. At any rate, Dr. N. F. Ticehurst, in a most delightful and exhaustive article on "Yellow Wagtails," in *British Birds* for October, shows conclusively that this bird must be looked upon as breeding regularly, in small numbers, in parts of Sussex, and this article he illustrates by means of a couple of photographs. Unfortunately, the publicity given to this fact when the first nesting locality was discovered led to the extermination of the colony by the "collector," who wanted "British-taken" specimens. Other localities discovered by Dr. Ticehurst have therefore wisely been kept secret.

Sandwich Tern in Norfolk.

In the *Zoologist* for October, Mr. J. G. Tuck records the fact that he had the good fortune to watch a Sandwich Tern disporting itself at Hunstanton on September 19, and again on the 21st, but breeding birds do not seem to have been noticed during the earlier part of the year.

White Ringed Plover.

White varieties of the plover tribe are by no means common; accordingly it is well that Mr. S. Whitaker has placed the fact on record in the *Zoologist* for October, that a white specimen of the Ringed Plover, which was shot on Westray, Orkneys, had just come into his possession.

Pallas's Sand Grouse in Middlesex.

A note in the *Field* (October 5) from Mr. W. W. Bladen has caused most of us to keep a sharp look-out for another immigration of Pallas's Sand Grouse. In the issue referred to, Mr. Bladen wrote to say that at noon on September 23, when sitting on the lawn of a house at Downage, Hendon, he saw a Pallas's Sand Grouse flying towards him. It was a single bird, and passed some 60 feet over his head, taking a course due north. So far, however, no other examples have been seen. Of course, it is possible that the bird seen was after all not a Sand Grouse.

Black-Tailed Godwit in Dorsetshire.

It is worth noting that a Black-tailed Godwit was seen on the Weymouth backwater on September 22, by Mr. J. D. Wignall, who has recorded the fact in the *Field* (October 5).

Extended Breeding Range of the Redshank.

It is a matter for considerable satisfaction to find that while many of our native birds are slowly decreasing in numbers—a decrease which, to their shame be it said, is materially aided by the egg "collectors"—one or two species appear to be extending their range. The Common Redshank is among this number, and some extremely interesting facts bearing thereon will be found in the October issue of *British Birds*, by Mr. A. H. Etches and the Editors.

PHYSICS.

By PROFESSOR ALFRED W. PORTER, B.Sc.

Change of Phase on Reflection of Light.

THERE has for a long time been evidence that when light is reflected from glass at nearly grazing incidence there is an abrupt change in phase of half a wave-length in the act of reflection. This was shown by means of Lloyd's interference fringes. The production of these fringes is so easy a matter that it will be useful to describe how it is done. Take a narrow vertical slit—such as can be made by making a clean cut through a sheet of tin foil fastened to glass. Illuminate it from behind with a monochromatic source, and in the path of the emerging beam place a strip of plate glass (1 inch vertical by 2 feet horizontal), so as to intercept part of it and reflect it at very nearly grazing incidence. On examining the edge of the glass furthest from the slit with a pocket lens, placed so as to receive both direct and reflected light, the ordinary diffraction fringes formed by a "straight-edge" will certainly be seen. If the glass strip be now rotated about a vertical axis a position will be found for which the fringes change character, becoming much sharper and also becoming equidistant. These are the interference fringes formed by the interference between the direct and reflected beams, and were first obtained by Humphrey Lloyd, of Dublin, who did so much in the early days of Fresnel's wave theory to afford experimental confirmation of it. To verify that there is a change of phase on reflection, all that is necessary is to observe that the edge of the glass is in the position of a black band; that is, it is the same distance from a black band that each of these is from a succeeding one. If there were no change of phase it would be only half this distance. This observation is a somewhat delicate one, and success may not be obtained at first.

Mr. P. V. Bevan (see *Philosophical Magazine* for October) has now succeeded in showing that a similar change of phase occurs when the reflection takes place internally from a water surface. All that is necessary is to place the slit horizontally and use as a reflecting surface the under side of the surface of a rectangular vessel of water. The fringes obtained are similar to those procured in the usual way, and, therefore, give evidence of a similar change of phase in the act of reflection.

The Effect of Pressure on the Arc Spectrum of Iron.

One of the most important results obtained by Mr. W. G. Duffield on the above subject is to show that the lines of iron can be grouped into series according to the amounts of displacement produced by pressure. Three groups can in this way be distinguished from one another, in which the displacements bear to one another approximately the ratios of 1, 2, and 4. Two lines give eight times the displacement, thus indicating a possible fourth group. The relation between displacement and pressure is approximately a linear one, but abnormal readings are obtained which indicate a displacement double of that which would be calculated from the linear law. These abnormalities appear to be connected with a tendency to reverse.

Changes in the relative intensity of the lines are produced by pressure—some lines are enhanced, others are weakened.

Professor Larmor contributes to the *Astrophysical Journal* for September a note on this subject suggested by the researches of Mr. Humphreys. He points out that the change must be connected with electric properties of the surrounding gas. Mechanical pressure arises merely from the translatory motions of the molecules, and these are so slow as

hardly to count in connection with radiation periods; thus the phenomenon is probably more strictly describable as a density-effect. Each molecule individually, through the agency of its plastic field of force or æther-strain, provides a yielding region in the æther in which the effective stiffness is diminished. The averaged-up effect is to diminish the effective elasticity which controls the propagation of the radiation. The elastic energy which maintains the free vibrations of an (atomic) radiator is located in its field of force in the surrounding æther, and by dynamical principles any loosening of the constraint in that field such as an adjacent molecule would produce, which would itself be somewhat intensified by equality of period, must, in general, tend toward increasing the free period, involving displacement of the radiation toward longer wave-length.

Rail Corrugation.

In a paper at the Sixth Annual Conference of the Municipal Tramways Association Mr. A. L. C. Fell gave it as his opinion, based on continued investigation of various tramway systems, that the corrugation of the rails (which has produced so much trouble and discussion) is not due to one cause alone. The following are some of the chief causes in his opinion :—(1) Original roughness of the rail after rolling; (2) cold rolling of rails by the car wheels; (3) soft rails and heavy cars; (4) sand and grit on head of rail; (5) defective and open joints; (6) tight or wide gauge of track or wheels; (7) loose or springy rails and joints; (8) defective trucks being out of square and buckling; (9) slip of wheels at curves; (10) wheels not being the same diameter; (11) flats on wheels; (12) rapid acceleration and retardation causing wheels to slip; (13) defective brake mechanism or by a too rapid application of the brakes causing chattering and a series of short skids.

Any of the above matters may be responsible for the trouble, but Mr. Fell considers that the "original sin" is produced in the act of rolling the rails, and will quickly develop into corrugation unless the surface of the rails is ground immediately after they are laid.

An abstract of this interesting paper appears in the *Electrician* for October 4.

Specific Heats of Gases at High Temperatures.

Drs. Holborn and Henning have recently determined at the Physikalisch-Technische Reichanstalt the specific heats of nitrogen, carbon dioxide, and water vapour for temperatures up to 1,400° C. The mean values for water vapour between 110° and any temperature increase faster than the temperature; those for carbon dioxide between 20° and any temperature increase more slowly than the temperature; while the curve for nitrogen is nearly a straight line.

ZOOLOGY.

By R. LYDEKKER.

The Restoration of Diprotodon.

EVERY attempt to restore the external form of extinct animals, if carried out on trustworthy lines, is a distinct gain to science, since it enables us to place the creatures thus reconstructed at least somewhere near their proper position in the zoological series. We are therefore glad to welcome a restoration by Dr. E. C. Stirling, of the Adelaide Museum, of the giant Australian marsupial (*Diprotodon*), of which the skeleton has for some months past been exhibited in the Central Hall of the Natural History Museum. As regards general contour, Dr. Stirling has followed the lines of a wombat, although with a certain increase in the relative length of the limbs. Since, however, the teeth and fore part of the skull are of the kangaroo type, with some indications of a greater development of the soft parts of the nasal region, the peculiar puffy and cushion-like muzzle of the kangaroo has been introduced, in a somewhat accentuated degree, into the restoration.

The Menagerie at Giza.

Captain Stanley Flower has favoured us with a copy of a list of new additions to the Zoological Gardens at Giza, Cairo. This amply demonstrates the energy with which the work of collecting is being carried on, and it is specially noteworthy that most of the new specimens belong to African species. Among the additions to which Captain Flower directs special attention is a male bonte-bok. This antelope, he remarks, is a most valuable addition to the collection; the species being unfortunately almost extinct. Apart from a herd preserved near Cape Agulhas, South Africa, it is believed there are only five examples now alive in the world, namely, one pair in South Russia, a cow and a bull of doubtful pure blood in Berlin, and the magnificent pure-bred Giza bull, which was obtained by purchase from Herr C. Reiche, of Alfeld.

From Reptile to Man.

Evidence of the intimate relationship between mammals and the carnivorous Triassic reptiles (anomodonts) of South Africa is gradually accumulating; one of the latest additions to our knowledge in this respect being made by Dr. R. Broom. It has long been known that in the human subject, and apparently in mammals generally, there exists a remarkable peculiarity in the development of the metacarpal bones of the hand and the metatarsals (or corresponding elements) of the foot. In the metacarpal (or first joint) of the thumb and the metatarsal of the great toe the separate cap, or epiphysis, is situated at the basal extremity, whereas in all the other metacarpals and metatarsals it is developed at the opposite end of the bone. No explanation of this anomaly is given in text-books, but the solution of the puzzle has at last been found by Dr. Broom. He has discovered that in anomodonts the outermost of the second row of bones in the wrist and the ankle is so elongated as almost to resemble a metacarpal or metatarsal. Owing to this elongation, the main joint of the thumb and great toe appears to have been between the wrist or ankle and the metacarpal or metatarsal (as the case may be), while in the case of the other digits this joint was situated between the metacarpal or metatarsal and the first segment of the fingers or toes. Those ends of the bones which took part in the main joint would be the last to ossify, and would determine the points where the caps, or epiphyses, would form. The aforesaid anomaly in this respect in the human subject seems therefore to be a direct inheritance from reptilian ancestors.

The Dissimilarity of Mammal Embryos.

Ever since the publication of Haeckel's figures of the early embryos of the fowl, the pig, the rabbit, and man, it has been a generally accepted dictum that the early developmental stages of widely sundered species of mammals are practically indistinguishable from one another. Romanes, for instance, in reference to the human embryo, observes, "at a certain stage it becomes evident that he is to be a mammal; but not till later can it be said to which order he belongs." W. A. Parker, again, in referring to mammal embryos at the stage representing a gill-bearing vertebrate, sums up by the statement that "know one, know all; one diagram would represent all, one description serves for all."

This "uniformitarian view" is totally challenged by an American writer, Dr. F. T. Lewis, who observes that, "As drawings of embryos, the well-known figures of Haeckel are totally valueless. The front limbs have been transferred to the neck, and the characteristic features by which anyone familiar with embryos can distinguish a pig from a rabbit wholly overlooked. The comparative study of embryos to detect generic and specific differences has not been carried far, but it is evident that at no stage in their development is there a confusing similarity in external form."

It is added that in the rodent order at a very early stage, the embryos of a squirrel, a mouse, a guinea-pig, and a rabbit are markedly distinct from one another; but in the squirrel group it has not yet been practicable to differentiate between those of a suslik, a prairie-dog, a squirrel, and a chip-munk.

XUM

The Reappearance of Apus.

So far as British zoology is concerned, the event of the month is the reappearance of the curious fresh-water crustacean *Apus*, which appears to have been unrecorded in our islands for a period approaching half a century. It has recently been found, according to a letter in *Nature*, in a pool in Kirkcudbrightshire. In Great Britain it appears to have always been local and rare; but in many parts of the Continent it may be extremely abundant one season and just as scarce the next.

REVIEWS OF BOOKS.

ASTRONOMY.

The Moon in Modern Astronomy, by Philip Fauth. Translated by Joseph McCabe, with an introduction by J. E. Gore, F.R.A.S. (London: A. Owen and Co.; 160 pp., with 66 illustrations and a frontispiece; 10s. net).—The sub-title of this book is "A Summary of Twenty Years' Selenographic Work, and a Study of Recent Problems." Herr Fauth has devoted a great amount of time to making observations and drawings of the moon at his observatory at Landstuhl, equipped with refractors of 6½ and 7-inch apertures, and in so far as this book is a summary of his own work and its results it seems eminently satisfactory. We do not know whether he belongs to the narrow sect of those who think good work can only be done with apertures of 6½ to 7 inches, but we certainly get the impression from his conclusions that very little good work has been, or is being, done in selenography, except at Landstuhl, which seems rather hard on the successors of W. R. Birt. It may also be objected that selenography is not the only branch of lunar astronomy, and that such work as that of Lord Rosse and Professor E. W. Brown, widely differing *inter se* and also from Herr Fauth's, need not be ignored in a book on "The Moon in Modern Astronomy." Mr. Gore's introduction serves admirably to prepare the reader who knows nothing of the subject for the chapters that follow. He agrees with some, but apparently not all, of Herr Fauth's conclusions. We cannot consider that the latter has made out a good case for a thick layer of ice covering the moon, though we can admit the plausibility of some of his notions. It strikes us as hardly fair to criticise a technical word like "crater," which after all is only a Greek word, meaning a "cup," and has no absolutely necessary connection with volcanoes. Apparently his critical faculty would prefer to call them "saucers." By readers specially interested in the subject, the book should not be missed, though it certainly fails to do justice to much modern work; but to the general reader or the astronomer whose tastes lie in a different direction, it will not, we imagine, appeal very strongly.

BOTANY.

An Introduction to Vegetable Physiology, by Professor J. Reynolds Green, F.R.S. (London: J. and A. Churchill; 10s. 6d. net).—The appearance of a second edition of this excellent and well-known work will be a source of gratification alike to its author and to those botanists who feel that the somewhat neglected branch of botany with which it deals has at last been acknowledged as essential to a thorough knowledge of plant life. Although modestly styled an introduction, as such it is a very substantial one, and the student who thoroughly masters its contents will be in a position to consult with benefit the more advanced works on the subject indicated by the author. On the other hand, many of the traditional statements abounding in older botanical works will have to be unlearned, such as the sharp differentiation between plants and animals, turning on the organic and inorganic nature of their respective food, functions of stomata, etc. The general treatment is broad, comprehensive, and to the point. The numerous illustrations are excellent.

MICROSCOPY.

Microscopy; the Construction, Theory, and Use of the Microscope, by Edmund J. Spitta, L.R.C.P., M.R.C.S., &c. (London: John Murray, 1907; pp. xx. and 468, with 16 plates containing 47 half-tone reproductions of photo-micrographs and 241 illustrations in text; 12s. 6d. net).—Mr. Spitta's handsome book is dedicated to the members of the Quekett Microscopical Club, and that enthusiastic company of microscopists will doubtless heartily welcome their President's addition to the numerous existing books on the microscope. It should also be of service to not a few workers outside the large body of amateurs, but it is questionable if many medical and biological students will be able to snatch time from their other more insistent studies to peruse the pages of so portly a volume. That they would do so with profit needs no saying, but the book will probably receive most appreciation from amateur workers. To begin with, it is almost entirely a book on "Brass and Glass," in other words, it deals with the microscope alone—the preparation of objects is left entirely untouched, and probably, considering the wide and varied nature of the subject, with advantage. It is an interesting book to anyone who uses the microscope as an instrument having higher claims than those of a mere magnifying glass, the wording is clear and simple, even colloquial, and many matters are dealt with that are adequately treated only in one or two large books on the subject. There is perhaps a redundancy of expression, and an over anxiety to avoid wounding the susceptibilities of each and every maker of microscopes and objectives, whether by sins of omission or commission, so that the pages are swollen by descriptions of innumerable microscopes and lenses, whilst with regard to the latter, Mr. Spitta finds himself constrained to praise almost every good lens on the market in terms such as must have made a heavy strain on his stock of adjectives. One lens, indeed, is somewhat contradictorily described as "the finest on the market, being only equalled by"—two others, which are duly mentioned. But these are small matters. Much of the book is devoted to explaining on familiar lines the elementary principles of microscopical optics, the explanation of achromatic correction and of apo-chromatism being especially clear and lucid, and to describing the various microscopes, lenses, and accessories on the market. The chapter on the use of the microscope is somewhat diffuse and inadequate for the serious worker who would need it most, and that on the choice of microscopes and lenses for various purposes, with the pages devoted to the opinions of some "experts"—the ambiguous inverted commas are Mr. Spitta's—is not very helpful. The long chapter on testing objectives is, however, excellent, but the most interesting and valuable part of the book is unquestionably to be found in the final chapters devoted to the theory of microscopical vision and its recent developments and controversies. That these are the work of Mr. Conrady enhances their value, and their interest is not lessened because they are evidently meant as a counter-statement to other theories that have recently received much prominence. The illustrative plates are most beautiful examples of the photo-micrographer's art, and confirm what we already know of Mr. Spitta's skill in such work.

PHYSICS.

The New Physics, by L. Poincaré (London: Kegan Paul; 5s.).—Written with the aim of making known the new observations and theories of the last decade without too great an insistence on purely technical details, and thus giving the general reader an insight into the advances that have been made. The parts which will attract chief attention are those on radioactivity, conduction in gases, X-rays, wireless telegraphy, and kindred matters; but it would be unfair to direct attention only to these. The great developments in the doctrine of energy and in thermodynamics, our knowledge of solutions (osmotic pressure, etc.), are carefully explained. Altogether we can commend the book (which is a translation from the original by Mr. F. Legge) to anyone who wishes to learn the trend of modern physics. In places we think that, perhaps, a more detailed and illustrated statement would have been found more acceptable. Much of the work referred to is difficult work, and though to the expert it seems very simple, some may go away with the impression that the explanations have not been "popular" enough. We do not think, however, that anyone will fail

to learn a great deal from it. We notice a very few mistakes of one kind or another. For example, on page 320 instability (in reference to the electron) should be stability.

SCHOLASTIC.

A Second German Course for Science Students, by Prof. H. G. Fiedler and F. E. Sandbach (London: Alexander Moring, Limited, 1906; price 2s. 6d.; pp. 76); **A German Science Reader**, by William H. Wait, Ph.D. (New York: The Macmillan Company, 1907; pp. 321; price 4s. 6d.).—Every science student requires to be able to read papers on his own subject in German. It is not necessary for him to learn to write German correctly—in fact, it is impossible for the average Englishman to do so—because all Germans can read English papers and are in the constant habit of doing so. Both books consist of reading exercises on scientific subjects. Professor Fiedler's, which we prefer of the two, consists of actual selections from recent writings in the form of short articles of about a page or two in length. In it the original spelling has been retained where variations exist in different papers. This plan is much better than that adopted by Dr. Wait, who has reduced the spelling in the main to that found in Duden's "Orthographisches Wörterbuch." As differences exist in the papers themselves, it is important that the student should be accustomed to them from the outset. Dr. Wait's book possesses a still more serious defect. A reader containing articles on chemistry, physics, geology, mineralogy, astronomy, and anatomy, and nothing on mathematics, is like a needle without an eye. No science student can consider his education in German complete unless he can read papers of a mathematical character. Botany is also unrepresented. The same fault appears also in Dr. Fiedler's book. The paper on the planimeter (p. 49) is the only exercise connected in any way, and that very indirectly, with mathematical ideas, while physics and chemistry are over represented. The deficiency will make itself felt by students other than those whose object in learning German is to enable them to read books and papers on pure and applied mathematics.

A new and revised edition of Professor Perry's **Practical Mathematics**, has been issued by the Board of Education, South Kensington. The copy received from the author is marked "New Edition—Many Printer's Errors." The spirit of the book, which is the important feature, is well deserving of the careful consideration of all persons engaged in elementary teaching.

Cartesian Plane Geometry. Part I.: Analytical Conics, by C. A. Scott, D.Sc. (London: Dent and Co., 1907; 5s.).—This, another of Dent's Series of Mathematical and Scientific Text-Books, edited by W. J. Greenstreet, M.A., F.R.A.S., forms a good elementary text-book on analytical conics in Cartesian rectangular co-ordinates, including the idea of the circular points at infinity. The distinctive feature of the book is the systematic use of line-co-ordinates as well as point co-ordinates. Examples requiring purely geometrical methods are generally avoided.

MISCELLANEOUS.

The Second Report of the Welcome Research Laboratories at the Gordon Memorial College, Khartoum, by Andrew Balfour, M.D., B.Sc., &c., Director, Department of Education, Soudan Government, 1906.—This report, which is nearly twice the size of its predecessor, must be regarded as a splendid record of work of a very arduous kind, carried out under very considerable difficulties. The series of memoirs here presented deal, for the most part, with the investigations which have been carried on since the publication of the first report in 1904 for the purpose of fighting such dread diseases as malaria and trypanosomiasis, though this by no means represents the total range of the work which has been done. A pile of most valuable facts, for example, is here presented concerning the insects and vegetable parasites injurious to plants. The section on Locusts, their life-history, and the means to be adopted for their destruction, which falls under this head, is especially valuable. Mr. E. E. Austen, of the British Museum of Natural History, contributes a chapter on Blood-sucking Diptera from the Anglo-Egyptian Soudan, which must prove of the highest value to those working in the field on this subject. His descriptions are rendered the more easy to follow by a series of coloured illustrations of rare beauty. No less helpful are similar contributions by Mr. F. V. Theobald on Human and Animal Pests, such as the Maggot-fly, Stingless Bees, and Forest Flies, and on the Mosquitoes or Culicidæ of the Soudan. But undoubtedly the most important pages of this report are those devoted to the description of the experimental work on Trypanosomiasis and Malaria. The results of these experiments should prove of the highest service to those who are engaged in the arduous work of fighting these scourges in other parts of Africa. So far trypanosomiasis has defied successful treatment, but experiments are now to be tried with a view to testing the value of the Malay fish poison *Derris elliptica* as a therapeutic agent. The report on the Chemical Laboratory shows no less evidence of hard work and originality, and proves most interesting and valuable reading to those of us who are but little likely to visit these laboratories, or to participate in the work that is being carried on therein. A novel use for asbestos is described here, this substance having been woven into shrouds for interments, which took place in a cemetery at Naga, probably about 1,500 years ago. But whether this was a Moslem burying ground, or not, is not yet known. This report should be read by all who are interested in the progress of science, and in its application to human needs.

The Distillation of Resins, by V. Schweizer (London: Maclaren and Sons; pp. viii. and 183; 10s. 6d.).—This book is essentially a practical one, and adds little to our knowledge of the nature of resins. It gives descriptions of the chief processes used in obtaining and preparing these substances into commercial products such as resin soap, lubricants, and varnishes. The latter part of the book deals with the manufacture of carbon pigments and their incorporation with oil to form printing inks, and there is a final chapter on the making of ink for typewriting machines, which contains much useful information. The book is well illustrated, but the printing leaves much to be desired, and there is no index.

BOOKS RECEIVED.

London University Guide and University Correspondence College Calendar, 1908 (Cambridge: University Tutorial Press Ld. pp. 208 and 63, Gratis).

The New Matriculation Heat. By R. W. STEWART, D.Sc. (Cambridge: University Tutorial Press, Ltd., 1907, pp. 276, 2s. 6d.).

The Patents and Designs Act, 1907. By J. ROBERTS and H. F. MOULTON (London: Butterworth & Co., 1907, pp. 128, 4s. net).

The Bible in the Full Light of Modern Science. New edition. By W. WOODS SMYTH (London: Simpkin, Marshall & Co., 1907, pp. 64, 1s. 6d. net).

The Living Greek Language Compared with the Ancient. By G. SPYRIDIS (Athens: K. BECK, 1907, pp. 356. No price stated).

A Scheme for the Detection of the More Common Classes of Carbon Compounds. By F. E. WESTON, B.Sc. (London: Longmans, Green & Co., 1907, pp. 95, 2s. 6d.)

CATALOGUES.—We have received from Mr. Charles Baker, of 244, High Holborn, copies of two important catalogues which he has recently issued. The first is the October edition of his quarterly classified list of second-hand scientific instruments, including microscopes, telescopes, spectroscopes, optical lanterns, field and opera glasses, together with a variety of accessories, and apparatus for physical and other demonstration purposes. In all there are over a thousand items of the total value of about £6,000. The other is his catalogue of surveying and drawing instruments, which is very complete, covering every requirement for use both in the field and drawing office. We notice that a large variety of cases of drawing instruments are described in detail, thus facilitating the choice of a set best suited to a given class of work.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

Preparation of Microscopical Objects.

(*Continued from page* 238.)

The object is generally fastened firmly in the feeding tube by wedges of elder-pith, carrot, or cork, or even embedded in paraffin; other hand microtomes have an adjustable clamp at the side by which the object is held in place in a tight-fitting sleeve which allows of the necessary movement up and down. The well-known Cathcart microtome is really a modification of these simple hand microtomes, but it is fitted with such a clamp as is just mentioned, it fastens on to the table, and instead of having a circular plate to serve as support to the razor it has two parallel side supports covered with glass. There is an even more elaborate pattern made in which the side supports are covered with brass and upon them runs a simple carrier to hold the razor rigid whilst it travels to and fro. Moreover the screw-head for feeding has graduated teeth and an arrangement for recording the amount of movement, and an additional fitment consists of an interchangeable plate, bottle, and bellows for ether-freezing. The cheapest hand-microtomes can be purchased for a few shillings; the Cathcart microtome costs from 17s. 6d. to 27s. according to its fittings. Even those who possess the more costly and elaborate microtomes which will be described presently can find many uses for one of the simpler forms just mentioned.

The ordinary razor is generally used for all forms of hand section-cutting, but as many of the sections cut by hand are those which are too hard or too uneven in their consistence to be satisfactory, in more elaborate microtomes it is well to provide oneself with a special strong razor blade mounted in a rigid handle, such as most microscope dealers supply for about the price of an ordinary razor. For cutting very hard sections such as wood nothing is better than a good plane iron enclosed in a wooden handle, and one of the drawbacks to the more elaborate Cathcart microtome with its brass slides as against the old glass faces is that this plane iron cannot, of course, be used.

For the finest and most delicate work microtomes of great precision are necessary, and these are now made in great variety by many makers. It is curious that with the exception of the "Cambridge Rocking Microtome" and of Leake's microtome, to be presently described, all these are of Continental or American manufacture. The oldest of the types now in use is the Jung-Thoma microtome, based upon the Rivet model. It consists of a solid heavy casting on the top of which are parallel slides in which a block runs to which is clamped a projecting knife, and this block and knife are drawn by hand backwards and forwards on the slides. At the side of the casting, and thus beneath the knife, is another set of parallel slides which slope diagonally upwards. On these slides runs a carriage, which forms a carrier for the object, and the carrier is pushed onwards and, therefore, upwards on the slides by means of a screw which is clamped in the requisite position and turned by hand as required. By this means a fairly coarse thread can be given to the screw, and yet the resultant vertical movement of the object remains slight. (*To be continued.*)

Compound Eye of Insect.

The compound eye of the insect has always been of great interest, not only because of its perfect adaptation, but on account of its structure. In many insects the eye covers practically the whole of each lateral surface of the head, and is seen under the microscope to be made up of innumerable hexagonal facets, each facet having a different optic axis, so that the whole field of view around the insect is taken in. Each facet is, in one sense, a separate eye, and is provided with its own homologue to the rods and cones of the retina of the human eye, and it has been much debated whether a simple or a multiple image results. The subject is discussed at some length in Carpenter, and a photograph by Exner is reproduced there showing a single reproduction of the letter R upon a window-pane photographed through the compound eye of a fire-fly. It is noteworthy that the R in the photograph is reversed, but not inverted. In the Journal of the Quekett Microscopical Club for April, 1906, is printed a paper which was read by Mr. E. J. Spitta, who called

attention to certain points which are of interest, namely, that in the insect eye the so-called rods and cones of the retina are probably more or less in contact with the lenses instead of separated as in the human eye by the limpid "vitreous humour," and that there are probably no lenses in each facet in the ordinary sense of the word, but that the image is probably what is known as a pin-hole image, and that thus the difficulty of variation of focus is got rid of. Mr. Spitta also called attention to the fact that in Exner's experiment the retina and pigment above alluded to were removed from the eye, and glycerine and water of a refractive index of 1.346 substituted, but that Exner overlooked the fact that this really converted the eye into a lens of this refractive index, which, of course, with the help of the microscope, photographed the window and letter R according to ordinary rules just as if the cornea were not there. Mr. R. T. Lewis has since stated that when the original print was shown by Professor Exner to the Royal Microscopical Society in 1890 he made a rough copy of it in his note-book, and this showed the letter R the right way round and *not*

reversed as in Carpenter. One or two further points were brought out in the subsequent discussion, amongst them Mr. Rheinberg's suggestion that the image must be formed at the portion of the retina which was furthest away from the pyramids as no pin-hole image could be formed immediately behind the facet, and Mr. Conrady's that as they were dealing with lenses of 1-100th inch focal length, objects an inch away would be at an infinite distance for such lenses, and, therefore, in focus. In the course of his paper Mr. Spitta explained how he had photographed some perforated zinc and then repeated the operation several times until he had got perforations so small as almost to require a lens to see them. He then placed the artificial cornea on the stage of the microscope and placed a little cross on a piece of glass beneath, whereupon a little cross was seen in each tiny hole of the photograph of the zinc, a result unquestionably due to pin-hole effects. The whole discussion is of interest, though the last word has doubtless not yet been said upon the matter. It may be of interest to many of my readers to know that it is quite easy to form these multiple images in the compound eye of an insect. A dragon-fly's eye is very suitable. It must be carefully cut out with scissors, snipping it all round, and the inner portion washed away with a camel-hair brush. After thorough cleansing, the eye must be soaked in turpentine for a considerable period to render it soft and transparent, and then mounted with gentle and gradual pressure to get it flat. This is often the most difficult part, as the convex eye has naurally a tendency to split at the edges. If the insect eye be now placed upon the stage of the microscope and the edge of the lamp-flame focussed upon it as in ordinary critical illumination, it will be found that a slight throwing of the condenser out of focus will produce an image of the lamp-flame in each facet. An even more striking result can be got by putting a small object on the mirror and brightly illuminating it, or, better still, a small photograph. Such a portrait can be even photographed in this position, as the accompanying photograph, taken from one about half an inch square, will show.

Microscopical Material.

Mr. C. E. Heath, of Cardiff, has very kindly sent me a further supply of washed foraminiferal shore gatherings from Dog's Bay, Galway, Ireland, consisting almost entirely of minute shells. I shall be pleased to send a small quantity of these to any reader who cares to apply to me for the same. Applications must be accompanied by a very small tin box, a stamped addressed envelope, and the coupon to be found in the advertisement pages of this issue of "KNOWLEDGE."

Notes and Queries.

Mounting in Glycerine.—Mr. H. O. Walker, of Parramatta, N.S.W., writes: "As I have a number of slides of glycerine mounts prepared by myself from 1879 to 1883, which are in perfect order, it may perhaps be of use to you to know that I consider the chief thing in glycerine mounting is never to use gold size until you have first put on two or three coats of sealing-wax varnish. I have had a good many mounts become cloudy, and in every case the cell had been sealed with gold size, of which glycerine is a solvent. No mounts in which the cells were sealed with sealing-wax varnish have deteriorated in any way. My slides were at one time about five years without having a fresh coat of varnish, but it is wise to give a coat of gold size every year. Most of my cells were of tin or zinc, cemented on to the slips with black asphalt varnish (baked). I have tried marine glue and shellac, but the asphalt proved most reliable. Cement cells made with sealing-wax varnish have also stood well. I have them twenty-six years old. After many years I have recently mounted some Acari in glycerine, using my old methods, which have stood so well. I have never used glycerine jelly."

Manchester Microscopical Society.—This Society has issued the annual list of lectures under its extension scheme. Many of my readers will be aware of the excellent work done in this way by the Society, but for those living in Manchester and the neighbourhood, and in the neighbouring parts of Yorkshire, etc., I may say that members of the Society provide lecturers on a variety of microscopical subjects without payment save for actual out-of-pocket expenses, except in the case of commercial undertakings, where a modest fee of one guinea extra is charged. Practical demonstrations in mounting, etc., are also given. The list sent me contains lectures on no less than 44 different subjects, zoological, botanical, geological, and general. For further information application should be made to the Hon. Secretary, Mr. F. B. Cocker, 22, Filey Road, Fallowfield, Manchester.

W. Watson and Sons' New Catalogue.—This new catalogue of 164 pages contains full particulars of the well-known "Van Heurck," "Edinburgh Student's," "Fram," and the newer "Praxis" and "Bactil" microscopes, with specifications and prices for work of all kinds, from the most elaborate outfit to one suited to the slenderest purse. The excellence of design and workmanship of these microscopes, even the least costly, has been proved for many years. Amongst new additions to the catalogue I notice an inexpensive "Searcher" microscope, with fine and course adjustment, sold at £1 17s. 6d., without lenses, and several portable higher power instruments. The list of accessories is very full, and now includes blood-testing instruments, bacteriological apparatus, and microtomes of various patterns, as well as photo-micrographic apparatus, amongst which is the Watson-Conrady condensing system, perhaps the most perfectly corrected one made. Amongst new objectives is a ⅙ inch achromatic lens from a new computation by Mr. Conrady, which has a numerical aperture of .74, but a working distance of not less that a millimetre. The short working distance of an ordinary ⅙ inch lens is the chief drawback to its use, especially in making blood counts, and in examining slides which have rather thick cover-glasses, so that this new lens should meet with a ready sale. I have myself had the opportunity of inspecting one, and can speak highly of its definition and corrections both for spherical aberration and for colour. It is a really admirable lens, with a performance out of all proportion to what its aperture would lead one to anticipate.

Ernst Leitz's New Catalogues.—Mr. Ernst Leitz sends me new catalogues of microscopes, microtomes, and of Edinger's projection apparatus, all beautifully printed and illustrated. It is worth noting that the more expensive stands are now being fitted with a greatly improved and sensitive form of fine adjustment, which shows the trend of Continental makers to follow the practice of the best English stands in this respect. Some of the stands show further improvement in a modification of the old horse-shoe stand to one more of a claw-shape. Amongst new instruments is a microscope with a stage 20 cm. square, for examining brain sections, new mineralogical stands, a simplified arrangement for demonstrating "ultra-microscopic particles," by Siedentopf and Zsigmondy's method (the word "demonstrating" has a significance that should not be lost sight of), and a new opaque illuminator fitted with a side lens, to increase the light. The microtome catalogue contains many models, from the large sliding microtomes of the now accepted type, but with several excellent modifications, and the Minot serial microtome, to the less expensive student's hand microtomes. In particular, there is a simple microtome which consists merely of a freezing plate for the object, and of two adjustable side rests for the knife or razor, which screws on to a cylinder of carbon dioxide gas.

[Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge. Correspondents are requested not to send specimens to be named.]

The Face of the Sky for November.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.54 and sets at 4.34; on the 30th he rises at 7.43 and sets at 3.54. Sunspots have lately been fairly conspicuous.

The positions of the Sun's axis, and of the centre of the disc are given in the appended table:—

Date.	Axis inclined from N. point.	Centre N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Nov. 2 ..	24° 34′E	4° 13′	71° 4′
,, 7 ..	23° 36′	3° 41′	5° 8′
,, 12 ..	22° 27′	3° 7′	399° 13′
,, 17 ..	21° 7′	2° 32′	233° 18′
,, 22 ..	19° 35′	1° 56′	167° 23′
,, 27 ..	17° 52′	1° 18′	101° 29′
Dec. 2 ..	15° 59′E	0° 40′	35° 36′

THE MOON:—

Date.	Phases.	H. M.
Nov. 5 ..	● New Moon	10 39 p.m.
,, 12 ..	☽ First Quarter	5 14 p.m.
,, 20 ..	○ Full Moon	0 4 a.m.
,, 28 ..	☾ Last Quarter	4 21 a.m.
,, 9 ..	Perigee	6 0 a.m.
,, 25 ..	Apogee	5 48 a.m.

OCCULTATIONS.—The following are the principal occultations visible at Greenwich:—

Date.	Star's Name.	Magnitude.	Disappearance		Reappearance.	
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.
			p. m.		p. m.	
Nov. 18	μ Ceti	4·4	5 7	87°	6 1	226°
			a. m.		a. m.	
,, 22	ζ Tauri	3·0	5 6	42°	5 54	313°
,, 24	δ Geminorum ..	3·6	3 41	81°	5 1	291°

THE PLANETS.—Mercury (Nov. 1, R.A. 15h 46m; Dec. S. 22° 46′. Nov. 30, R.A. 15h 1m; Dec. S. 14° 35′) is an evening star in Libra until the 14th, on which date he is in inferior conjunction with the Sun. On the evening of the 7th the planet is in conjunction with Venus, Mercury being 1° 54′ S.

TRANSIT OF MERCURY.—A transit of the planet across the Sun's disc takes place on the 14th, the time occupied being from about 10.25 a.m. to 1.50 p.m. The transit is visible over West and Central Europe and the whole of Africa, as well as the major part of South America.

The apparent diameter of the planet is 9″·8, thus the diameter of Mercury to that of the Sun is about 1 to 200, but during transit it usually appears larger than this. Transits of Mercury are comparatively frequent, and when occuring take place in either May or November. The last transit was visible in Great Britain just before sunset in November, 1894; the next transit will be in November, 1914, and visible in this country from beginning to end. Only one transit was visible throughout in this country during the last century, viz., that of May, 1832. The times of the various contacts calculated for Greenwich are as follows:—

First external contact, Nov. 14d, 10h 23m 24s a.m.
First internal ,, ,, 10h 26m 1s a.m.
Second internal ,, ,, 1h 48m 10s p.m.
Second external ,, ,, 1h 50m 50s p.m.

The planet appears to enter the Solar disc on the Eastern side at an angle of 62° from the North point and leave it on the Western side at an angle of 15° from the North point.

Venus (Nov. 1, R.A. 15h 11m; Dec. S. 17° 36′. Nov. 30, R.A. 17h 45m; Dec. S. 24° 21′) is an evening star on the confines of Libra and Scorpio. The planet sets at 4.53 p.m. on the 15th, and thus is not well placed for observation.

Mars (Nov. 1, R.A. 20h 59m; Dec. S. 19° 27′. Nov. 30, R.A. 22h 14m; Dec. S. 12° 22′) is on the meridian about 6 p.m. throughout the month. The brightness of the planet is rapidly diminishing; the apparent diameter being about 10″ as compared with 23″ at opposition. The planet, however, is fairly conspicuous with its ruddy colour, and with diminished South declination is in a convenient position for observation during early evening. The planet is in conjunction with the Moon on the 12th at 4 p.m., Mars being to the North.

Jupiter (Nov. 1, R.A. 8h 59m; Dec. N. 17° 37′. Nov. 30, R.A. 9h 5m; Dec. N. 17° 19′) may now be well observed before midnight, rising on the 1st at 10.40 p.m., and on the 30th at 8.53 p.m. During the month the planet may be observed in the S.E. portion of the sky about 10 p.m., and forms an obtuse angled triangle with the bright stars Castor and Pollux. The equatorial diameter of the planet is about 39″, whilst the polar diameter is 2″·5 smaller. This difference is noticeable even in small telescopes in which also the dark belts and bright satellites may readily be observed.

Saturn (Nov. 1, R.A. 23h 31m; Dec. S. 5° 42′. Nov. 30, R.A. 23h 29m; Dec. S. 5° 48′), in Aquarius, remains in a favourable position for observation, crossing the meridian at 8.51 p.m. on the 1st and at 6.56 p.m. on the 30th. The planet is situated a few degrees below the great square of Pegasus, and is readily detected with his peculiar leaden lustre. The motion of the planet is retrograde until the stationary point is reached on the 25th, after which it is direct. At the middle of the month the polar diameter of the globe is 17″, and the ring appears closed. At 10 p.m. on the 14th, the planet is in conjunction with the Moon.

Uranus (Nov. 15, R.A. 18h 44m; Dec. S. 23° 25′) is unfavourably placed for observation on account of its southerly declination and proximity to the Sun. The planet is in Sagittarius, setting at 8 p.m. on the 1st and at 6.5 p.m. on the 30th.

Neptune (Nov. 15, R.A. 7h 3m; Dec. N. 21° 48′) rises shortly after 7 p.m. and crosses the meridian at 3.27 a.m. on the 15th. The planet is situated about 1½° N.W. of ζ Geminorum.

METEORS.—The principal meteor showers during the month are the Leonids and Andromedids:—

Date.	Radiant.		Characteristics.
	R.A.	Dec.	
Nov. 14-16 ..	10h 0m	+22°	Swift, streaks. (*Great Leonid* shower.)
,, 17-23 ..	1h 40m	+43°	Very slow, trains. (Great Andromedid shower.)

Algol will be at minimum at 10 p.m. on the 17th; and at 6.50 p.m on the 20th.

Mira (o Ceti) is due at maximum on the 15th, and observations should be made for some weeks on either side of this date, since the period is irregular. Last year the star was unusually bright.

TELESCOPIC OBJECTS:—

Double Stars.— η Cassiopeiæ 0h 43m, N. 57° 17′, mags. 3½, 7½; separation 5″·9. Binary star.

λ Arietis 1h 52m, N. 23° 6′, mags. 4, 8; separation, 37″. Components white and blue; easy with power 20.

η Persei 2h 44m, N. 55° 28′, mags. 4, 8; separation 28″. The brighter component is orange, the other blue. There are also several other fainter stars very near.